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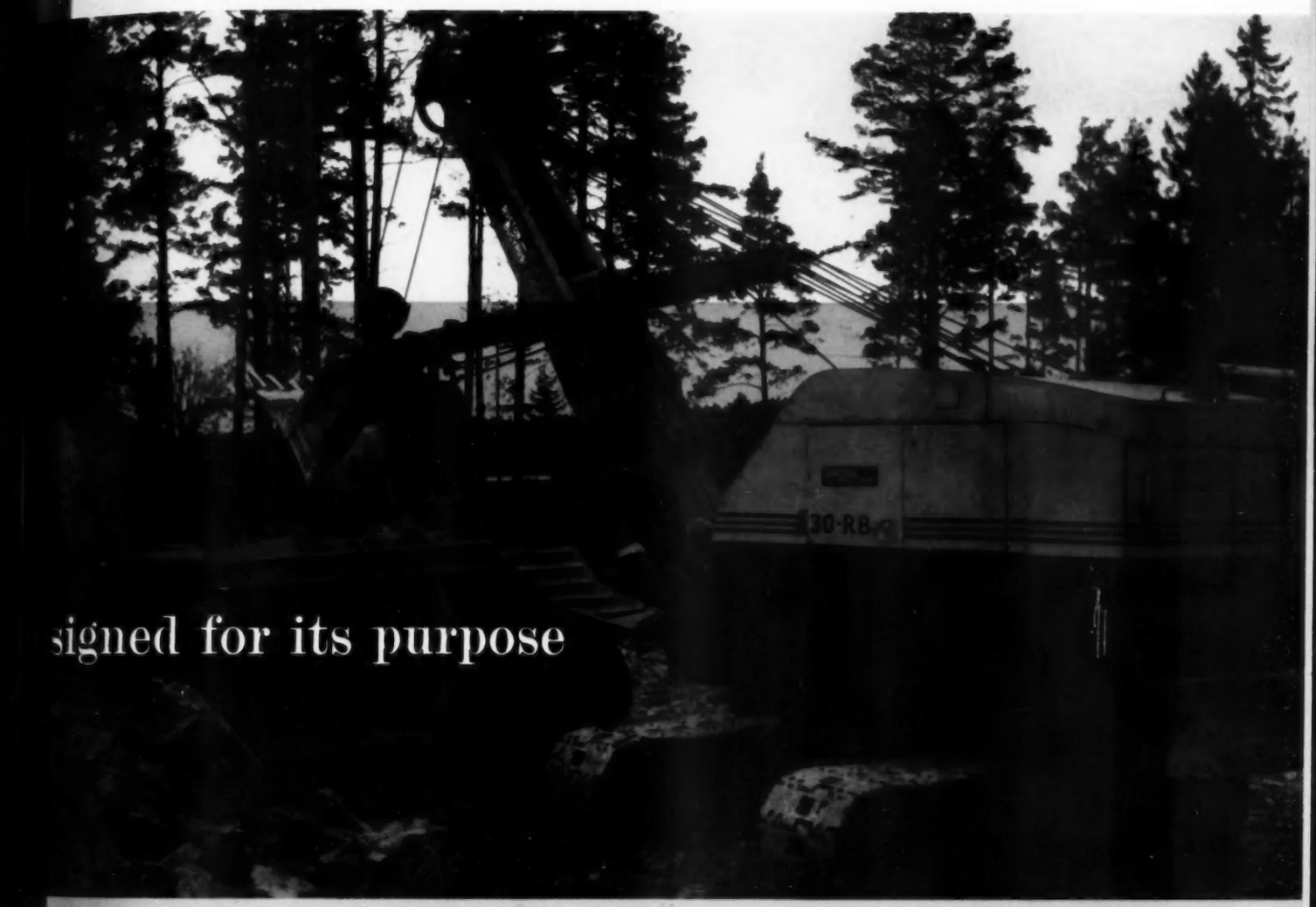

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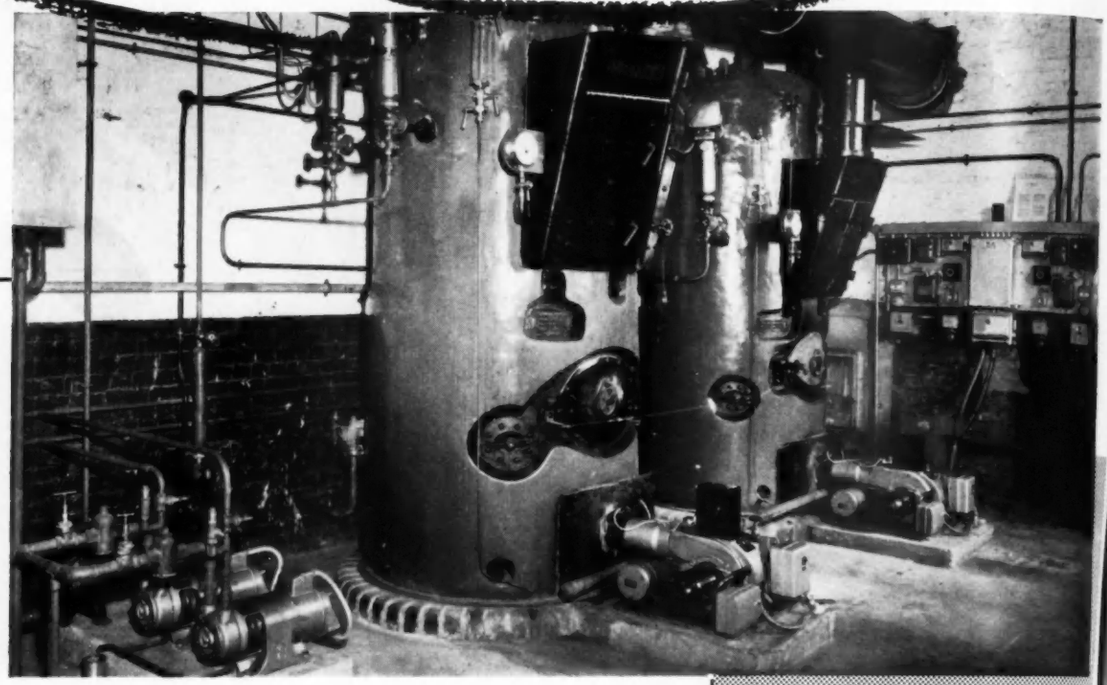

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THE ENGINEER

Established 1856

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THE ENGINEER

No. 5495 MAY 19, 1961 Vol. 211

"CAPABILITY" BROWN IN THE TWENTIETH CENTURY

Would any sober, responsible, engineer praise the work of a colleague by describing it as "rollicking"? Surely not. Yet he might, at times, envy another profession where such a light-hearted epithet would not be out of place. That was, in fact, the word used by Mr. Jellicoe to describe the landscaping of a roundabout and pedestrian subway at Basildon. Part of his exposition—given in a paper at the Institution of Civil Engineers on Thursday of last week on "The Collaboration of Civil Engineering and Landscape Architecture from the Point of View of the Landscape Architect" — was printed in last week's issue of THE ENGINEER. The subject is, indeed, important and fascinating. The scale of present-day engineering structures — the motorway or the nuclear power station for instance — is so vast as to tend to dwarf the relatively intimate proportions of the surrounding countryside. There are exceptions such as the Trawsfynydd power station, where the rugged mountain sides and the large building will be in a harmony of contrast. Otherwise skilful artistry and artefact are needed to achieve a result which has beauty as well as utility. The philosophy of a "Capability" Brown has to be turned from the creation of the vistas of a great estate to the more difficult tasks of "rounding off the sharp corners" of vast industrial projects, and giving them a visual setting appropriate to the higher material standards which it is their function to provide. For this purpose, a new profession is becoming established, and the meeting last Thursday was welcome in drawing attention to its problems and aims. Mr. Chettoe in his paper " . . . from the Point of View of the Civil Engineer" raised matters which will be readily appreciated by all engineers, and reflected the deep interest which many engineers have for these aspects of their work, which they label — sometimes, perhaps, rather self-consciously—"æsthetics." It is unfortunate that such a deep and undesirable division exists between the "utility" of the civil engineer and the "art" of the architect. This division was rather emphasised by Mr. Jellicoe in his introduction, where he used what is termed in advertising the "depth" approach to justify an emotional rather than a utilitarian attitude. Here we are on contentious ground, and many of his engineering readers, we suspect, might have been somewhat sceptical. But not when we turn to actual achievement, in his landscape designs for Oldbury and Harwell. When these projects are complete — and also others such as the dams at Tryweryn and Derwent (Northumberland) which were recently the subject of a similar paper by Mr. F. Gibberd (see the *Journal of the Institution of Water Engineers* for March, 1961) and the landscape scheme envisaged at Drakelow power station which was mentioned in the "Civils" discussion — we shall be able to judge the success of the modern landscape architect in grappling with quite unprecedented problems. Perhaps, like "Capability" Brown, he will be able to say "the Thames will never forgive me for what I have done here"; that would be success indeed.

HANOVER FAIR

Following the accustomed ten days of hectic activity the Hanover Fair recently closed its gates. With over 5000 exhibitions—nearly 1000 from abroad—and some 100,000 visitors each day, this year's Fair has been the largest to date. Brought into being in 1947 with the purpose of replacing Leipzig, it has swept well ahead of its East German contemporary which is now making strenuous efforts to achieve, within the Eastern orbit, a position similar to that of Hanover in the West. The Hanover industrial fair is probably the largest event of its kind in the world. Since the days when it first opened, in a disused wartime factory, it has grown at an average rate of 18 per cent per annum. The exhibition grounds now extend over 823,000 square metres, not including car parks for 40,000 vehicles and other transport facilities. The site is such that this area could be substantially expanded if need be. Over 300,000 square metres are under roof, and the open-air exhibition exceeds 200,000 square metres. For many miles around, hotel and private accommodation is taken up by visitors who arrive by car, tram, train, and even by aerial taxi. The success of the Hanover Fair is partly due to the well-tried "firstest with the mostest," partly the result of enterprising foresight and years of painstaking planning.

Voices are raised periodically to suggest that there is an urgent need for similar facilities in this country. But whether there is a real need to attempt to compete with the Hanover Fair is doubtful. The trend in this country has been away from such all-embracing exhibitions and towards a multiplicity of smaller more specialised shows. Yet there can be no doubt of the need for better exhibition halls than any that exist at present and especially for a hall in which the really heavy engineering products of British industry could be adequately displayed. At least once since the war an authoritative committee has recommended Government action; but nothing has come of it. We feel sure, however, that this view will one day be recognised sufficiently widely for something at last to be done. When this happens, we hope that some lessons from Hanover will have been learned. A start should be made on a site not too hemmed in by existing buildings but provided with transport facilities of all kinds including car parks. The utmost effort must be made to make visitors welcome by providing an efficient accommodation service, information officers and interpreters, restaurants, shops, banking, and postal and telephone services within the precincts of the exhibition. It goes without saying that the buildings should be pleasant

to look at, and fully adequate for all present and foreseeable future requirements, so that even the largest and heaviest exhibits can be housed and demonstrated in operation.

GOLDEN JUBILEE OF THE INSTITUTION OF LOCOMOTIVE ENGINEERS

When the Institution of Locomotive Engineers was inaugurated in 1911 it is probable even the more optimistic of its founder members failed to foresee the extent of its growth and the authoritative position it would attain during its first fifty years, both of which were reflected in the number and status of the members and guests present at the Jubilee luncheon in London last week. The Institution was founded by a group which broke away from the Stephenson Society (afterwards the Stephenson Locomotive Society) and much of its initial impetus was given by Mr. G. F. Burtt, of the L.B. and S.C.R. works at Brighton. He was the first honorary secretary and treasurer, a dual post which he held for many years. From its inception the new Institution was very active, and as the years passed new centres at which members met regularly were opened both in this country and overseas. Its main interest for many years centred naturally upon the steam locomotive, but over the past decade the increasing adoption of diesel and electric traction by railways has been reflected both in its papers and the growing membership. As was the case with steam locomotives, papers on the newer forms of traction have held to a high standard, which will ensure the future well-being of the Institution. It might well be said that the golden jubilee of the Institution of Locomotive Engineers marks the closing page in steam locomotive history. But the strong and vigorous nature of the Institution is such that we feel sure it will not fail to maintain in the future the object stated in its memorandum of association — "the advancement of the science and practice of locomotive engineering by discussion, inquiry, research, experiment and other means." What the future holds for railway motive power may be difficult to foresee, but all interested in locomotives will congratulate the Institution on the completion of its fifty years and wish it well.

SAFETY IN THE WORKS

A month or two ago a "Golden Eye" Club was formed. To qualify for membership one has to have had one's sight saved through the wearing of safety goggles. Now there has been founded a "Golden Shoe" Club. Membership is open to anyone who is able to prove that thanks to wearing safety shoes or boots he escaped from what would otherwise have been a serious foot injury. At a function at the Criterion Hotel in London on Tuesday of last week Mr. Tom Reid, who works as an assistant on a machine which is used for inserting bags into uncured tyres at a works of the Firestone Tyre and Rubber Company Ltd., was formally installed as the first member. At the time of the accident he had one foot on the floor and one on the base of the machine. Movement of the platform of the machine trapped Tom's foot. But though the shoe was reduced to a wreck — it was on show at the function — the steel toe-cap remained intact. Tom suffered nothing worse than a painful bruise on the ball of his foot.

Safety boots have, of course, been known for quite a long time. Even before the war the late Sir Alfred Herbert, amongst others, was trying hard to get them accepted amongst his workmen. But it proved an uphill battle; and even to this day one can find men working in, of all places, foundries, wearing gym shoes or carpet slippers! In the past part of the objection taken to the wearing of safety boots could undoubtedly be traced to the heavy and clumsy appearance of early examples. There can be no such objection now. A number of examples were on show by International Safety Products, Ltd., for which several manufacturers provide shoes and boots made to B.S.I. standards. Only upon very close inspection could these products be distinguished from the ordinary products of shoemakers; at a casual glance the difference would not be observed. We learned that these products are made available to workers at wholesale prices which means that in fact they are cheaper than ordinary shoes. There is a nice little quirk of human nature involved in getting workers to accept them. Firms are advised not to offer to supply shoes freely; the result of such an offer is likely to be that fewer pairs will be worn than if the shoes are sold! The address of the new Golden Shoe Club is 134, Wigmore Street, London, W.1.

GAS INDUSTRY FEEDSTOCKS

For some years important changes have been taking place in the gas industry of this country, and the presidential address and papers presented at the annual general meeting of the Institution of Gas Engineers give a good indication of future trends. In his presidential address Mr. Hugh S. Cheetham said that there were now in operation and under construction high-pressure, oxygen-using plants, gasifying coal and oil, and other plants reforming gases at high efficiencies. The further efforts being made to increase the efficiencies of these plants would be, however, of little avail unless cheap feedstocks could be purchased. Of this fact there can be no doubt and it would appear that competition to supply such feedstocks will increase in attempts to meet the requirements of the new gas industry which is rapidly emerging. Further, a paper presented by Mr. D. R. Coote dealing with the refinery gas reforming plant at the Romford works of the North Thames Gas Board showed how outputs and efficiencies had risen to levels higher than initially reported two years ago.

The gas industry has long been, and indeed still is, largely dependent upon coal for its feedstock, but the trends over the past few years, brought out clearly at the meetings of the Institution of Gas Engineers and elsewhere, indicate that the coal industry will have to face increasing competition for one of its most valuable customers. The use of an indigenous feedstock should be explored to its fullest extent as is being done for example at the Westfield works, shortly to be inaugurated, and in the investigations now being made under the auspices of the N.C.B. and the gas industry. But the pressure of economics must be faced and the coal industry must be prepared in the not too distant future to accept the loss of still more valuable custom if it cannot do more to compete in price with other feedstocks available to the gas industry.

A NEW USE FOR THE "POLARIS" SUBMARINE

Analysing the grand inquest which the Commons completed some time ago on the Government's defence proposals and the Fighting Services' Estimates, it is clear that members on both sides of the House were worried about the number and types of ships best suited for the future Navy and what the Navy

was intended to do in war. On two points there was general agreement. Because seapower can be quickly concentrated and brought to bear where it is needed, the Royal Navy's first task is to help in preventing a local outbreak developing into a more serious conflict. It was also the general view that once an all-out mass destruction war had started, the Navy would have no further useful rôle to play. But the recent change in the Government's defence policy presents a problem which not only has a fundamental bearing on the future of the Navy. It depends for its solution on the soundness of one of two opposing views. Britain is no longer thinking in terms of full nuclear retaliation to major aggression. Her policy is to retaliate with all the means available and *which are judged necessary* to deal with any particular situation. The Royal Navy may well be concerned in this process of "graded" retaliation which again must depend on what action the enemy is taking. Since a major war in Europe must sooner or later lead to the suicide of both parties attack on the sea communications on a gradually increasing scale seems a possible course of action for the enemy if he wants to bring pressure to bear. How far would Russia go in furtherance of a foreign policy — supporting an insurrection in Persia or in the Middle East — which was being resisted by force by one or more of the N.A.T.O. nations? It is on the answer to this question that both statesmen and military experts hold fundamentally different views.

On the one hand it is argued that the use of nuclear or thermo-nuclear weapons against warships and merchant ships would be quite legitimate and give no good grounds for full-scale nuclear retaliation. On the other hand it is emphasised that for an enemy to attempt to achieve his aims in this way would be a slow business. There might well indeed come a time — depending on the extent of the menace — when the Allies would be forced to carry out nuclear attacks on the ports from which the enemy submarines were operating. Equally the Russians might make similar attacks on allied ports. It is thus difficult to conceive that in the long run a large scale war of this kind would remain conventional. Be that as it may, the present defence policy of "graded" retaliation suggests that unless Britain is to be dependent on her allies, she requires a fighting navy — something more than a prestige navy for use in peacetime and for helping to restore order in a small local campaign. Indeed, it may well be asked why limited tasks of this nature necessitate her having large expensive fleet carriers with the latest type of radar and other modern equipment. Nor does it seems necessary to continue building frigates to add to the substantial anti-submarine force already available — presumably for the protection of merchant ships in convoy — to deal with a few submarines which Russia has supplied to the United Arab Republic, Indonesia and China. There is indeed much to be said for the Opposition's view that the Royal Navy, as it is to-day, has no definite purpose — no clearly thought-out task to achieve in a serious conflict.

An answer to these conflicting views suggested by the Member for Croydon, North East, deserves serious consideration in view of his many years of service in the higher ranks of the Navy. Admiral Hughes-Hallett emphasises that the "Polaris" submarine is much more versatile than is commonly supposed and is capable not only of acting as a graded deterrent but could be used also for the defence of the sea communications. "Polaris" submarines would enable reversion to the traditional custom — a custom required by international law — of warning civilians in advance to evacuate a given target area. Not knowing where the vessels were, an enemy could do nothing about it except to threaten nuclear retaliation of a similar nature. This might well have terrible consequences, but would still fall far short of the Nemesis of total war. Employed tactically the "Polaris" submarine, 100ft deep, with her missiles set to explode at a reduced range, would listen for and detect any hostile ships in the area and destroy or seriously damage them by the simple process of firing a "Polaris" missile 3000ft into the air above them. The cost of a fleet of "Polaris" submarines would, in the Admiral's view, be manageable if they were built over a period of 20 years to replace the large fleet carriers, cruisers and V-bombers — not forgetting also the "Thor" rockets. This would leave the second class carriers — or converted merchant ship carriers — to operate helicopters, supported by assault ships, to deal with brush-fire campaigns. None the less it is by no means clear that "Polaris" submarines would be able to play a really useful part in the defence of the sea routes. An alternative solution might well be a financial arrangement with the United States under which Britain would build first class carriers, guided missile destroyers, and anti-submarine vessels for the defence of the sea routes, while manning and operating in peacetime some of the "Polaris" submarines built by the United States basically for the defence of all the N.A.T.O. nations. If, in accordance with her present plans, the United States decides to build forty-five of these submarines within the next five or ten years, it would seem a logical extension of the Holy Loch base principle that Britain should be asked to provide a base for, and to man and operate in peacetime, a substantial number of them.

The Engineer—100 Years Ago (MAY 17, 1861)

"The Great Eastern and Her Builder"

"Some months ago, when the arbitrators appointed by the Great Ship Company, awarded Mr. Scott Russell £18,000 for work done in the Great Eastern and not paid for, we took some pains to place the circumstances of the case before our readers, and to predict that no proceedings which the directors of the company could possibly take could overthrow the decision of the arbitrators. As the verification of the prediction has at length been completely established, we may, we hope, be permitted, not to extol our own powers of prophecy, but to point out the reckless nature of the opposition which has ever since been offered by the directors to the decisions of arbitrators selected by themselves. The additional legal expenses with which the shareholders have been saddled are burdensome enough, but how much worse would their position have been had Mr. Scott Russell reciprocated the spirit of these commercial people, knocked the ship down at the hammer to himself and left the company only the recollection that the last and greatest wonder of the world once belonged to them. We are happy to know that no such spirit actuated him, and the builder of the magnificent ship has added as little as possible to the troubles of her strange carreer.

"We cannot finally abandon this subject without contrasting once more the conduct of the man belonging to the profession which we represent, with that of the commercial people into whose hands the great ship fell.

"Our profession . . . is even more honoured by the conduct of the builder of the Great Eastern, than the commercial world has been dishonoured by her present owners."

The McFadzean Laboratory

The McFadzean Laboratory of the B.I.C.C. research organisation, Wood Lane, London, was officially opened by H.R.H. The Duke of Edinburgh on May 16. It houses four of the ten departments that constitute the firm's research organisation which exists to conduct basic research of a long-term character; to assist the engineering laboratories of the B.I.C.C. group with their more specific shorter range objectives; and to provide some of the very specialised services that are of common interest to these engineering laboratories. The following brief description of the McFadzean Laboratory is based on information obtained during a short tour of the Laboratory last week.

THE McFadzean Laboratory, is the most recent addition to the research organisaion of British Insulated Callender's Cables, Ltd., at Wood Lane, London. To appreciate the functions of this new laboratory as part of the B.I.C.C. organisation it should be understood that the engineering activities of the group are supported by laboratories located in each production unit. The main duties of these laboratories are to exercise quality control generally, to improve existing products by attention to the materials or the plant and processes used, to develop new products to the final production stage and to maintain technical liaison with customers and outside bodies.

The research organisation, concentrated in the Wood Lane laboratories is responsible for doing the long-range experimental work required to give the engineering laboratories the information they need to reach their shorter-range objectives, and for conducting basic research on subjects of long-term interest irrespective of their immediate applicability. Besides, the research organisation offers central services to the group's factories for work involving specialised staff or equipment which would be uneconomic or inefficently deployed in separate laboratories.

Accordingly the research organisation has ten experimental departments, each working in a well-defined field of science or technology; four of them are housed in the new building and the rest are in other buildings on the same site. All these departments are supported by a works engineering group with well equipped workshops.

The McFadzean Laboratory is a six-storey building which has 64,000 square feet of floor area and accommodates the following departments: instrumentation and control; physics; British Dielectric Research, Ltd. (a group subsidiary for research on capacitors); diffraction and microscopy; and an electronic computer operated by the mathematics department which has its main offices elsewhere. In addition the new building houses a drawing-office, a photographic section, a main conference room, a lecture room, some administration offices and catering and social services.

These departments were chosen to occupy the McFadzean Laboratory because they most need the atmospheric conditions provided by the complete air conditioning installed in the new building, while they do not need extensive provision for chemical research (which is carried out in other buildings). However, to permit limited chemical or physico-chemical work, the East wing of the building is equipped with chemical drainage and fumes extraction.

The Laboratory has a complete basement which, besides having accommodation for the storage of records, the electrical substation, refrigeration and space-heating plant and the automatic telephone equipment, provides a large space to be used for life-testing and similar long-term tests which need only occasional supervision.

The ground floor contains the entrance vestibule and the conference room but is otherwise wholly occupied by the instrumentation and control department. This department is one of those which provides a centralised service to the group and is responsible for: (*a*) developing novel measuring devices, mainly for use in the factories in non-destructive quality control testing; (*b*) designing and constructing complete schemes of instrumentation, using either specially developed or conventional equipment; (*c*) devising automatic production equipment to replace and improve upon existing manual control methods, to improve product quality or to economise in material usage.

Fig. 1—Measuring head of the continuous lead sheath gauge

A few examples which typify the work of this department are mentioned below.

1. The a.c. spark testing of rubber and plastic cable insulation has been standard practice for many years. The use of a d.c. spark of very low energy has advantages, particularly that it is non-destructive and non-lethal. A typical d.c. tester, incorporating a novel paper-tape recording device, is in use.

2. A coach belonging to the Eastern Region of British Railways stands in the siding adjacent to the laboratories and is being equipped with instrumentation for surveying the behaviour of overhead electrification equipment. Some of the instruments, which are similar to those provided for the London Midland Region test coach, which is already in service, are under test in the Laboratory.

3. The continuous vulcanisation process used in the production of rubber cables requires large and expensive plant which is unsuitable for research or development work. A flash vulcanising unit, which enables the fast vulcanising process to be studied in the Laboratory with ease, speed and economy, is installed and in use.

4. Many new devices are now available to facilitate the transport of wire through various cablemaking processes and to control quality. A demonstration wire-processing line includes several devices such as a controlled tensioner and a take-up spool for temporary storage needs of the continuous line.

5. Accurate control of thickness and concentricity of the lead pipe, which will be used for the Magna flexible submarine pipeline to convey natural gas from the mainland of British Columbia to Vancouver Island, is a vital necessity. A continuously-operating proximity gauge, now in its final development stages, is shown operating on a length of pipeline in Fig. 1.

The physics department occupies the whole of the first floor and nearly all its work is of a long-range nature and largely concerned with the dielectrics used for power cables. The most important topic, and one in which studies have been in progress for very many years, is research into the properties of dielectrics for very-high-voltage cables. With oil-impregnated paper dielectrics, for example, studies start with the manufacture in the Laboratory of the paper itself, which can then be tested in a range of instruments, some specially designed for the purpose, before being built up into cable models in which it is possible to reproduce all the conditions to which a full-size cable will be exposed during its manufacture and service life. The department has its own high-voltage testing equipment which is normally of adequate range but, if higher voltages or currents are needed, the larger facilities of the main high-voltage department are available.

There is a growing field of work in the possible use of plastics for high-voltage cables, but the more immediate advances are perhaps to be made in the fields of low-voltage insulation (rubbers, plastics and minerals, &c.) and appropriate research programmes are in progress.

Oil-impregnated paper is the only dielectric material which is yet being used for the higher voltage a.c. cables, the electrical properties of which depend on the properties and quality of the paper. To study the effects of different pulps, pulp-treatment processes and papermaking variables, the Laboratory has installed a miniature Fourdrinier paper-making machine

Several methods are used for assessing the quality of laboratory-made or commercial paper. For example a "Talysurf" surface measuring gauge for recording the surface uniformity of paper is in use.

Laboratory cable models, on which all electrical properties may be assessed, enable the effect of variables to be studied without manufacturing experimental full-size cables. Models of paper and plastic film cables are made for testing in the Laboratory; the paper-insulated cables samples are carefully lapped by hand, the paper tension being simply but accurately controlled by weights.

High-voltage equipment is used for testing the models (Fig. 2) both in impulse and alternating-current breakdown strength experiments.

The second floor is devoted to research on

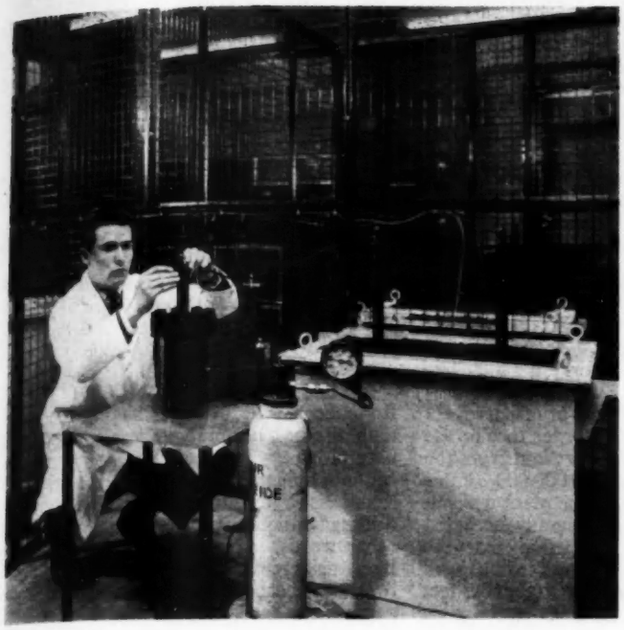


Fig. 2—Setting up a paper-insulated cable model for high-voltage test.

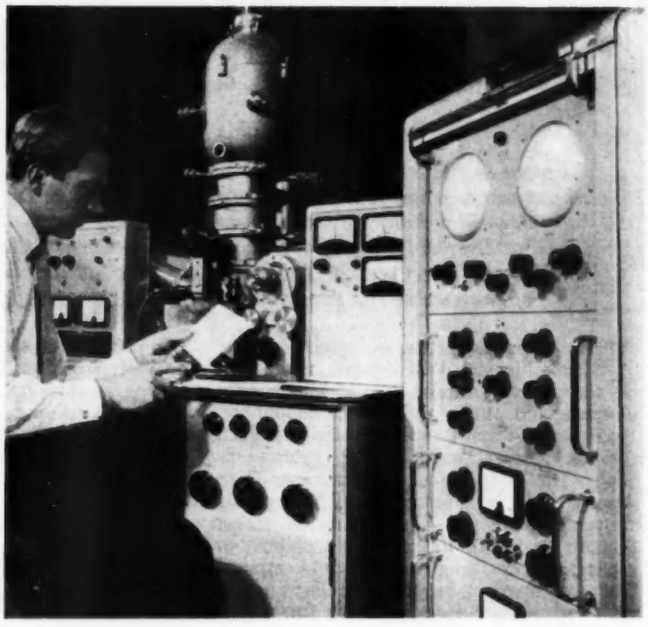


Fig. 3—X-ray scanning micro-analyser with oscillograph and recorder

capacitor dielectrics by British Dielectric Research Ltd., which serves both the capacitor division of B.I.C.C. and the Telegraph Condenser Company, Ltd., a B.I.C.C. subsidiary. This department has sections dealing with all kinds of capacitors—oil-impregnated paper, electrolytic, metallised plastic, ceramic, &c.—and possesses equipment for manufacturing laboratory specimens of all kinds. It also has an extensive range of measuring devices for the study of initial characteristics and life performance.

If gaseous cavities are present in a capacitor, the ionic discharges which may occur under electric stress can impair the efficiency of the capacitor and shorten its working life. Accordingly the measurement of ionisation in a paper capacitor, and the influence of pressure upon it is an important activity of this department.

The self-healing characteristic of vacuum-metallised plastic film permits the use of very thin dielectrics and, hence, enables the size of capacitors to be reduced. This characteristic was demonstrated both on individual films and in wound capacitors during our tour of the Laboratory.

The electrolytically-formed oxide film on certain metals may be employed as a capacitor dielectric. The method for forming the oxide on tantalum foil, and the changes which can take place in the oxide layer during service, were also demonstrated.

The third floor houses the drawing-office, the diffraction and microscopy department and the photographic section. The diffraction and microscopy department is concerned mainly with the fine structure of materials and provides an analytical service to all other departments of the organisation. It has its own research programmes, but they are mainly concerned with improvements in its own techniques. There are three main items of equipment.

The X-Ray micro-analyser (Fig. 3) is an instrument of recent development. Specimens are scanned by an electron beam only one-thousandth of a millimetre in diameter. The X-rays generated, the wavelengths of which are characteristic of the elements in the surface of the specimen, are analysed and the results displayed either visually on the screen of an oscillograph as an "X-ray image," or automatically recorded. This process enables elements which are present in minute quantity to be located and identified. The technique is especially valuable in metallurgical studies for the examination of segregates, alloying constituents, &c.

The X-ray diffraction camera is used in the identification of crystalline elements or compounds and for the determination of crystal orientation and texture. The techniques are all well established, but the instrument is still one of the most versatile of laboratory tools.

The photographic section has many routine duties, but it is also an essential part of the scientific facilities of the laboratories. Its extensive equipment includes high-speed cinematography, and photographic methods are frequently used for special measurements. An interesting example is in connection with the researches being carried out in the research organisation's Traction Research Laboratory at Tolworth, near London. There the behaviour of the overhead equipment used in electric railway traction is being studied by means of dynamically-similar scale models, (as described briefly in THE ENGINEER, October 21, 1960); and practically all the measurements are being made by cinematographic or special still photographic methods.

The only laboratory on the fourth floor of the new building is that containing the Elliott 405 electronic computer, which is used for mathematical and engineering design problems. The computer is particularly useful for the latter, because it has a much larger store than is usually needed for strictly mathematical work. A typical application is the calculation of the control requirements for installing heavy submarine power cables in deep water. The computer was first used for this purpose in 1956 when the group installed 93½ miles of 138kV gas-filled cables linking Vancouver Island with the mainland of British Columbia, and a typical example is the calculation of the control charts which will be used in the laying of the British section of the cross-Channel d.c. power cables for the England-France interconnection. Other work in hand includes the designing minimum-cost overhead power line towers, and the calculation of the sag/tension data required in overhead line installation.

The British Electrical Development Association Annual Luncheon

THE annual luncheon of the British Electrical Development Association was held at the Savoy Hotel, London, on Tuesday, May 9, and was attended by about 450 members and their guests, with the President, Sir Edwin Herbert, as chairman. The Right Honourable Alfred Robens proposed the toast of "Electrical Development," and welcomed the opportunity of speaking to the Coal Board's biggest customer. He said he realised the need to make more horsepower available at the elbow of labour so that more products would be available for export. Fundamentally the basis for power was coal, which was an indigenous product; however, he felt that it was vital that the producers of coal should not treat the electrical industry as a captive customer. Mr. Robens realised the part played by electrical equipment in making it possible for so many married women to be in industry, and also that to provide cheap electricity it was necessary to maintain coal at a stable price. He considered the possibility of long-term contracts and of reduction in price, and thought that the coal industry was only just beginning to harness power to the job, and that there was considerable leeway to make up in the matter of mechanisation. The coal industry, he said, was not as flexible as surface industries, but nevertheless production had to be maintained to justify the £1000 million investment since 1947, and it was hoped to double power loading this year, to attain 50 per cent level of mechanisation. In his response Sir Edwin Herbert briefly outlined early developments, and the rapid progress which led to the formation of one power industry. The electricity supply industry had changed the face of the countryside and revolutionised power application so that, whereas the steam age meant concentration, the electrical age had led to the dispersal of industry. These developments, he continued, had resulted in competition between various forms of power and had acted as a spur to efficiency. No doubt some amenities had suffered due to the siting of power stations, nevertheless, he emphasised, development was still going on and the electrical supply industry had been successful not only in increasing the thermal efficiency of the power stations but also in reducing the capital cost involved. He supported any refusal to submit to the tyranny of ideas, and went on to say that it was the consumer who was the arbiter of the pattern of fuel policy. Sir Edwin combined his response with proposing the toast of "Our Guests" on whose behalf Mr. Harold Woolley, the President of the National Farmers' Union, replied.

Pressure-Gasification in Germany

By Dr. Ing. HELLMUTH WEITTENHILLER

A paper dealing with pressure-gasification with oxygen of solid fuels in Germany which was presented to the Institution of Gas Engineers on Tuesday last described the practical operation of the coal-gasification plant installed by Steinkohlengas A.G. at Dorsten (Westphalia). It dealt with a number of recent developments whereby the Lurgi pressure gasification process could be improved and the cost of gas reduced. In this article we reproduce abstracts from the paper.

THE pressure-gasification plant of the Steinkohlengas A.G. located in the area of the Fürst Leopold-Baldur Colliery at Dorsten, and put into service in September, 1955, was the first large-scale plant designed for the gasification of caking bituminous coal. The main object of this paper is to report on the experience gained from nearly six years of practical plant operation, rather than to deal with theory of the process or separate process steps. It would appear, from a comparison between calculated figures and test measurements, that the forecasting of gasification results is possible only to a limited extent. A precise forecast in the real sense of the word cannot be made, as it cannot be predicted to what extent equilibrium will be established.

The following principles of all pressure-gasification processes, excluding the manufacture of synthesis gas, have been considered valid for the past thirty years :

(*a*) Elimination of nitrogen dilution by using oxygen of high purity instead of air as gasification agent ;

(*b*) Formation of a large quantity of methane in the gasifier.

These principles have now been superseded in Germany by our recently developed processes and by the increasing availability of natural gas. Up to a few years ago, natural gas was added to the manufactured gas in order to bring the calorific value up to town gas standard ; but in future, considerable quantities of natural gas and nitrogen will be added to the converted gas from the Dorsten pressure-gasification plant, without changing thereby the calorific value and specific gravity of the town gas produced. The basis for the processes was established in co-operation with Lurgi Gesellschaft für Wärmetechnik m.b.H., by the investigation of crude-gas conversion on a laboratory scale, in a pilot plant, and in a semi-technical unit, the latter having a throughput of 900,000 cubic foot per day of gas.

Plant Operation

Since so much has been written concerning gasification by the conventional Lurgi pressure-gasification process, I should like to concentrate in this paper on the practical operation of our plant and on the new processes and improvements developed in our works.

The heart of the plant comprises six gasifiers that were originally designed to supply 46,000,000 cubic feet per day at 450 B.Th.U. cubic feet. This quantity as well as all town gas data given later include the natural gas necessary to increase the calorific value from 400 B.Th.U. cubic feet to 485 B.Th.U. cubic feet. This constitutes a proportion of about 15 per cent by volume of the town gas. The town gas supplied at an actual calorific value of 485 B.Th.U. cubic feet is, in the following, recalculated to a calorific value of 450 B.Th.U. cubic feet.

The plant is now capable of supplying 75,000,000 cubic feet per day of gas, each pressure gasifier providing 15,000,000 cubic feet per day of town gas. There are then five pressure gasifiers working and one serving as standby.

The following provides a brief survey of the improvements made in order to increase the gasmaking capacity of the plant from the original 46,000,000 to 75,000,000 cubic feet per day of gas. When the plant was put into operation, it was a generally accepted principle of pressure gasification that the ratio of high-pressure steam to oxygen should be 35·5 lb of steam to 100 cubic feet of oxygen. However, at this ratio only about 25 per cent of the total steam input was decomposed. The remaining 75 per cent was converted from high-cost high-pressure steam (about 380 lb per square inch gauge) into low-cost low-pressure steam (70 lb per square inch gauge). This obviously increased the price of the gas produced.

There were also some other difficulties. It was found that the water-cooled grates leaked and that water passed into the gasifiers. This resulted in up to 1000 gallons per hour of water getting into the gasifier so that it was surprising that the gasifier still kept running. In the circumstances it was decided to cool the grate with steam and to use gasifier-jacket steam for this purpose. After the necessary modifications had been made to the gasifier, the gas output increased immediately. One reason for this was that uncontrolled quantities of water could no longer pass into the gasifier. However, another reason—and this is the more important one—was that the wet jacket steam is now dried and superheated inside the grate by indirect heat exchange with the hot ash.

The next step was to lower the temperature of the high-pressure steam, which reduced the inlet temperature of the steam/oxygen mixture by about 90 deg. Fah.

The gasifier requires a surplus of steam in the gasification agent to avoid an undue rise of the reaction temperature, resulting in the melting of the ash and the failure of the gasifier. By the stepwise reduction of the gasification-steam temperature, it was found possible to reduce the amount of surplus steam, which acts as cooling agent, without exceeding the ash-fusion temperature of the coal in the gasifier.

As compared with the previous "wet processing method," steam consumption went down from 9 lb to 5 lb per 100 cubic feet of purified gas. These modifications also made it possible to increase the coal throughput by 55 per cent. It was even found possible to increase the output of gas by 70 per cent. The gas contained less carbon dioxide and more carbon monoxide. In comparison, the consumption of oxygen increased only by 45 per cent. The reduction in the rate of high-pressure steam supply and the increase of total steam decomposition from 25 to 38 per cent by vol. resulted also in a lower production gas liquor. A rather pleasant side-effect was that the output of tar, oil and benzole also increased from a total of 16 gallons to 18 gallons per ton of coal. This processing method, which we call "dry operation," led to a considerable reduction in the cost of gas.

New Developments in Processing Techniques*

This Section describes two new processes developed at Dorsten, which have led to a considerable improvement in the economics of the Lurgi pressure-gasification process for the production of town gas and synthesis gas.

(*A*) *Carbon Monoxide Conversion of Hot Crude Gas using its Steam Content for the Reaction.*—The development of this new process was stimulated by the following considerations :

(*a*) The gas industry in the Federal Republic of Germany is making more and more use of the rapidly increasing supplies of natural gas. The market for natural gas can no longer keep up with the resources found as a result of the exploitation and drilling activities all over the country. In other words, supply exceeds demand. The large resources of natural gas must, therefore, be incorporated into the German town gas supply system at a minimum of cost, but with an optimum of flexibility. The idea therefore suggested itself to increase the proportion of natural gas that can be added to the gas produced in the Dorsten pressure-gasification plant by the provision of a highly economic conversion process.

Conversion of carbon monoxide with steam according to the equation

$$CO + H_2O \leftrightharpoons CO_2 + H_2$$

in effect converts 1 vol. of carbon monoxide into 1 vol. of hydrogen. Carbon dioxide is afterwards removed to a residual content of roughly 3 per cent by vol. The prime advantage of this crude gas conversion is the almost complete detoxification of the gas. The reduction of the specific gravity of the gas during conversion permits the addition of larger quantities of natural gas and nitrogen, without affecting the quality of the town gas.

(*b*) The conventional Lurgi pressure-gasification process still involved in spite of the improvements made by the introduction of the "dry processing method," the major disadvantage that less than 40 per cent of the total gasification steam was decomposed. Tests were directed initially towards the reduction of the carbon monoxide content, in the gasifier itself. It was, however, found that by increasing the rate of gasification steam to 8·2 lb per 100 cubic feet of crude gas produced, the carbon monoxide content in the purified gas did not drop below 23 per cent. In this so-called "cold operation," the velocity of reactions in the gasifier is decreased considerably, due to an excessive surplus of steam. Moreover, the high consumption of steam is rather costly, and steam decomposition is as low as 22 per cent.

The economic optimum of the gasification-steam rate is normally about 4·7 lb of steam per 100 cubic feet of crude gas for the Dorsten plant ; the gasification temperature under this condition is just below the ash-fusion temperature of the coal. These considerations stimulated the idea of converting the hot tar-laden crude gas in a separate unit with the aid of a catalyst.

After initial difficulties had been overcome, conversion tests on steam-saturated, crude gas proved successful, so that we now have available an excellent and cheap carbon monoxide conversion process.

In our system there are no steam costs, which were the main factor in the conventional carbon monoxide conversion processes.

* The information and test results given in (A) and (B) originate from the unpublished Ph.D. thesis of Diplo.-Chem. Harry Schoß.

We are now in a position to produce high quality gas, with a carbon monoxide content reduced from 23 to 4 per cent, without the addition of steam.

After the addition of the appropriate quantity of natural gas and nitrogen, which will be discussed later, the carbon monoxide content drops to as low as about 2 per cent which means that the gas is effectively detoxified.

To illustrate this, I should like to give some further explanations on paragraph (*a*). above.

The following example illustrates the principles stated above :

Our plant produces at present 62,300 cubic feet of purified gas per ton of coal substance with a calorific value of roughly 400 B.Th.U. cubic feet at a specific gravity of 0·464, with 4 per cent of inerts. For the adjustment of the calorific value to 485 B.Th.U. cubic feet, the addition of 12,100 cubic feet of natural gas (930 B.Th.U. cubic feet) is required, so that the total output of gas with a gross calorific value of 485 B.Th.U. cubic feet, a specific gravity of 0·436 and 5 per cent of inerts is 74,400 cubic feet per ton of coal substance during normal operations.

Converting the crude gas down to a residual carbon monoxide content of 6 per cent by vol. (which is the carbon monoxide content of most of the gas produced in the German coke oven plants and gas works), one has the same output of purified gas, i.e. 62,300 cubic feet. The thermal output remains the same, since 1 vol. of carbon monoxide is converted to 1 vol. of hydrogen, and these two gases have almost the same calorific value. The specific gravity, however, is reduced to 0·273.

Adding 20,000 cubic feet of natural gas and 18,680 cubic feet of nitrogen (supplied cost-free from the oxygen-generating plant), the specific gravity of the gas is brought back to 0·48, as during normal operation, with a calorific value of 485 B.Th.U. cubic feet. However, the content of inerts is higher at about 20 per cent which is still within permissible limits.

This scheme will increase the availability of low-cost peak-load gas by more than 50 per cent. Hence, it is possible to increase the supply of town gas per ton of coal substance by more than 50 per cent within a very short time by the addition of cheap natural gas. Under German economic conditions, this gas is less costly than any other conventional peak-load gas ; it is, indeed, not more costly than coke oven gas. The above method also reduces the toxicity of the gas considerably, contrary to the effect of most other peak-load gases from coke gasifiers, oil-cracking or natural gas-reforming plants.

If a higher proportion of carbon dioxide is left in the gas instead of nitrogen, the permissible quantity of natural or refinery gas to be added is much lower, due to the higher specific gravity of the carbon dioxide. Also, carbon dioxide is chemically active in the presence of water, which is a further reason for the preferential addition of nitrogen, particularly if the gas has to be stored.

At any specified calorific value the gas can be adjusted to any desired specific gravity within wide limits. The higher the allowable specific gravity of the town gas, the higher the addition of nitrogen and methane mixture can be. Instead of natural gas, liquefied petroleum gas may be added to the gas, in which case the quantity of additional low-cost peak gas will be reduced only slightly.

The higher output gives our works an increased flexibility in town gas supply. The minimum throughput of our gasifiers is 75 tons per day of coal substance, equal to a gas output of 5·6 million cubic feet per day. This throughput can be increased to 200 tons per day within a very short time. Accordingly, using crude-gas conversion, a total output of 22·6 million cubic feet per day, or roughly four times the minimum output without crude gas conversion, can be achieved.

Only in large-capacity plants can the full benefit from these processes be obtained. Applied to the gas industry, this would mean the integration of small gas works and the establishment of central stations, as has already been done in Great Britain.

The requirement of oxygen, using crude-gas conversion, is only 55 per cent of the demand during operation without crude-gas conversion, since the supply of 113,000 cubic feet of town gas requires only 62,300 cubic feet of crude gas. The requirements of oxygen may be reduced still further by the application of the process described in (*B*) below.

The process for crude-gas conversion, which is one of the factors in achieving exceptional flexibility, was developed at Dorsten over the last two years in laboratory and pilot-plant experiments. One of the problems was to find suitable active and sulphur-resistant catalysts for the conversion of the crude gas, which, after removal of dust and droplets, still contains valuable by-products such as tar, benzole, &c., in the form of vapour, as well as all impurities, such as organic sulphur compounds, hydrogen cyanide, hydrogen sulphide, &c.

We have examined in particular the refining effect that certain conversion catalysts have on the hydrocarbon vapours and impurities contained in the crude gas. The results obtained will lead to considerable further improvements in regard to economics and process techniques. The catalysts used reduced impurities such as hydrogen cyanide from 5 grammes per 100 cubic feet to 0·1 grammes per 100 cubic feet, and organic sulphur compounds from 11·8 grammes per 100 cubic feet to 1·3 grammes per 100 cubic feet.

The hydrocarbons boiling up to roughly 750 deg. Fah. remain in the crude gas leaving the gasifier because of their low partial pressure and are subjected to hydrogenation during crude-gas conversion. The proportion of lower-boiling components, such as benzole, increases at the expense of the higher-boiling components ; oils, &c., are desulphurised. A further advantage should be mentioned, namely, the reduction of gas liquor, which was largely due to undecomposed steam. The steam decomposition increases from 38 per cent to 50 to 60 per cent, under optimum operating conditions of the gasifiers with crude-gas conversion.

(*B*) *Pressure Gasification of Solid Fuels with Oxygen-Enriched Air.*—As already mentioned, a considerable amount of nitrogen has to be added to the town gas in order to adjust its specific gravity. By the addition of large quantities of air to the gasification agent, and the application of specific process techniques, we have been able to prove experimentally that a number of further considerable improvements can be achieved in conventional pressure gasification. For the purpose of the test, the gas to the pilot conversion plant was taken from the outlet of one generator, which was supplied with oxygen enriched air.

The following gives a brief survey of the advantages gained :

(1) Steam decomposition, which had been increased to a maximum of 38 per cent by "dry operation" was further increased to 50 to 60 per cent, using crude-gas conversion, without air addition, and to above 85 per cent by crude-gas conversion with the addition of air, and by the application of specific operating conditions and process techniques.

This new process step enabled the adjustment of a ratio of high-pressure steam : total oxygen of 15·4 lb : 100 cubic feet as compared to 23·6 lb :100 cubic feet attained previously, under optimum operating conditions of the gasifiers.

The requirements of high-pressure steam for gasification are reduced by more than 30 per cent and the output of gas liquor is much lower, due to the lower steam consumption and the high degree of steam decomposition. The proportion of carbon monoxide in the crude gas increased by the process, is converted into hydrogen and carbon dioxide by using the undecomposed gasification steam contained in the crude gas.

(2) The new process increases the quantity of purified gas (on a nitrogen and carbon-dioxide-free basis) produced in the gasifier per volume of oxygen and unit weight of coal substance consumed.

(3) Since a substantial proportion of the oxygen required for gasification is introduced into the process with the air, less oxygen needs to be produced by air fractionation, resulting in a reduction of power cost.

(4) Also, this has led to a reserve capacity being available in the oxygen plant at Dorsten. With the present two air separation units, using crude gas conversion, it will in the future be possible to produce a maximum output of town gas of 112 million cubic feet per day calculated on a calorific value of 450 B.Th.U. cubic feet.

If one oxygen unit fails, the gas output would normally drop to 56,000,000 cubic feet per day. Operating with air addition, we cannot use the total amount of air previously added because the specific gravity of the town gas would become too high. However, we would be able to use some extra air, to produce at least an extra 18,000,000 cubic feet of gas, which means that the output would drop only to 74,000,000 cubic feet per day and not to 56,000,000 cubic feet per day in case of one unit failing.

In other words, the oxygen plant can in future be designed for a smaller capacity, resulting in the saving of investment cost.

Future Operation and Economic Advantages of the New Processes

As described, three main steps were taken towards the reduction of the cost of gas production. The first step was the introduction of "dry operation"; the second step was the development of crude-gas conversion ; and the third step was the operation of the plant with oxygen-enriched air under specific operating conditions.

It would not be expedient to give any figures in respect of the savings reached, because these figures depend on the local cost of energy and labour. However, it may be said that the original production cost of the town gas has been reduced by 20 per cent. This reduction is attributable to "dry operation," crude-gas conversion and operation with air addition in equal proportions. These considerable savings reduce the production cost of our gas, under full load conditions, to a price that is equal to that of the surplus gas from coke oven plants.

This reduction in the cost of the gas production does not take into account the better quality of the gas, namely, that it is now effectively detoxified. In addition, we

are able to introduce large quantities of natural gas into standard town gas without any thermal or thermo-catalytic reforming.

These measures provide also great flexibility of the gasification plant and enable us to cope with peak requirements, without the peak gas being more expensive than ordinary coke oven gas. This system of meeting peak-load requirements should also be of interest to Great Britain, even if natural gas should not become available, because refinery gas, mixtures of propane and butane or other low-boiling hydro-carbons can be used instead of natural gas for enrichment. In future, we shall be able to supply 60 per cent of the thermal content of the town gas supply from unreformed natural gas.

Finally, it should be stressed that the present development is a matter of general interest. While six years ago natural gas was used to bring the Lurgi gas to town gas quality, the Lurgi gas will in future be used to bring the natural gas to town gas quality. Under the prevailing conditions in Germany, this may be regarded as a rather fortunate combination between the interests of coal and natural gas, which would otherwise enter into very strong competition.

Inspection of Military Equipment

Last week the Inspectorate of Fighting Vehicles and Mechanical Equipment held its first series of Open Days at the Farnborough Test House. The exhibition revealed the facilities available there and illustrated some of the work performed by the Inspectorate.

PROCUREMENT of tanks and other vehicles by the Army calls for an appropriate inspection organisation, and it was largely to fill this requirement that the Inspectorate of Fighting Vehicles and Mechanical Equipment came into being. The Inspectorate now forms part of the War Office Inspection Organisation and is responsible to the Assistant Master General of Ordnance (Inspection). This position dates only from 1960, when the inspection functions previously performed under the former Ministry of Supply were divided between the Ministry of Aviation and the War Office. However, the Inspectorate can trace its development prior to 1939, when the inspection of tanks and other vehicles began to be separated from the inspection of weapons. It took much of its present form under the Ministry of Supply, assuming responsibility not only for all facets of fighting vehicle procurement for the Army but also for the inspection of all types of vehicles for the three services, the Home Office, the G.P.O., the Foreign Office and overseas customers ; in 1958, when it took on its present title, it also assumed responsibility for bridging and certain other engineering stores.

The Inspectorate consists of two main groups : the Technical Direction Group and the Services and Regions Group. The former has five branches, each responsible for the provision of technical direction on contracts for a particular class of equipment. Thus, there is an " A " Vehicles Branch which is concerned chiefly with fighting vehicles, an Engineering Branch concerned with the inspection of a wide range of wheeled vehicles and plant equipment, a Structures Branch which deals with bridging equipment, works stores such as hutting, stillages and other constructional items, and gauges for the whole Inspectorate. There is also a Materials Branch divided into four sections dealing with metallurgy, armour and welding, protective treatments, and metal finishing and non-metallic materials, and a Packaging Branch, whose main task is the preparation of packaging specifications for the stores with which the Inspectorate is concerned. In addition to the five equipment branches, there is also a Publications Branch responsible for the production of user and technical handbooks for all equipment for which the I.F.V.M.E. is responsible.

The Services and Regions Group is responsible for the executive inspection of equipment during and on completion of production. The country is divided into five regions and the regional staff cover the day-to-day inspection of current contracts, prototype inspection when required, investigation of a firm's inspection organisation for approval and the subsequent supervision of such an organisation. In turn, the regional staff obtain technical direction from the appropriate branch of the Technical Direction Group.

The Services and Regions Group also contains a Quality Assessment Group and the Test House. The former covers the whole country and fulfils its function by spot checks at contractors' plants, firing proofs, and the complete strip examination of vehicles at the Test House.

Test House

The Test House, located at Farnborough, Hampshire, serves as the ultimate authority within the Inspectorate with regard to dimensions, performance and material state, and provides services such as gauge making and training examiners. Work at the Test House embraces oil testing, design and manufacture of inspection equipment, metrology, material and radiographic testing and the critical examination of assemblies and components.

It should be pointed out that oil testing at the Test House is concerned with the mechanical performance of engine and gear oils for Service use and one of the more interesting exhibits in the oil test laboratory was a Petter W.1 engine used for oxidation tests on cylinder liners. In the materials laboratory, which contained the usual range of mechanical testing machines and a 50-ton Amsler machine, there were also several examples of radiographic techniques, including gamma-ray apparatus and a large gantry-mounted 400kV X-ray unit capable of penetrating up to 5·5in of steel and used for the inspection of large castings and of welds, the maximum size photographic plates used with this unit being 17in by 14in.

Another type of material testing, that of the assessment of the ballistic quality of rolled armour plate, was illustrated by a 122mm plate which had been subjected to attack at normal impact by 76·2mm 17-pounder armour-piercing shot at different velocities. The assessment is based largely on the extent of damage evident on the back of the armour plate, but it is interesting to note that of the several shots fired at the plate those with velocities ranging from 1826ft to 1863ft per second failed to penetrate, in contrast to those with velocities of 1940ft to 1992ft per second which achieved penetration. Apart from the question of penetration, other important points are the amount of bulging at the back of the plate, flaking and break-up, and the results of firing tests with one plate out of a batch are generally related to its Brinell hardness number which is then used as the basis of inspection of the rest of the batch.

An entirely different aspect of material testing was illustrated by a humidity cabinet used to determine the resistance of components to mycological attack. The cabinet simulated tropical conditions and contained electrical insulation material which had been sprayed with a spores suspension containing seven different cultures, typical of the fungi encountered in the field, and held for twenty-

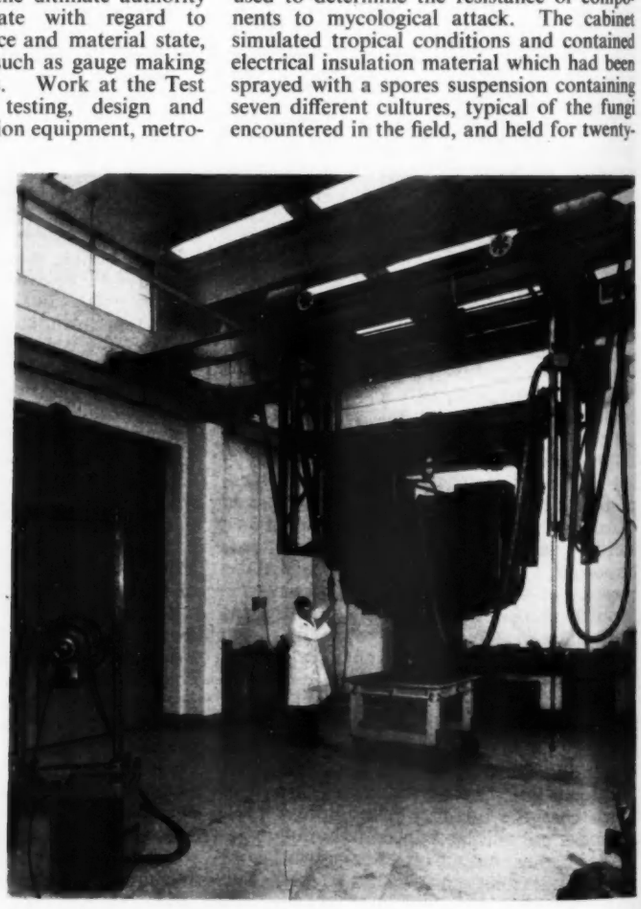


Fig. 1—400kV X-ray unit used for the inspection of large castings and welding

eight days at a constant temperature of 86 deg. Fah., which is necessary for incubation. The test is then continued for a further eighty-four days maximum, the temperature being varied each day, the daily cycle including five hours at a minimum temperature of 76 deg. Fah. and twelve hours at a maximum temperature of 96 deg. Fah., while the relative humidity is maintained at 95 to 100 per cent.

Yet another type of test was exhibited by the Structures Branch which proof tests every panel of the Heavy Assault Floating Bridge, or H.A.F.B., by subjecting it consecutively to three types of load which produce maximum tension in the bottom chord, maximum shear with co-existing bending, and maximum shear between the panel and anchorage pins. The loads are applied in a specially designed rig which incorporates three separate hydraulic loading cylinders and is capable of producing a maximum load of 175 tons, the actual maximum load used being 130 tons or 110 per cent of maximum working load.

The dimensional accuracy of these bridging panels is very important and the gauges used to check their dimensions showed an interesting application of glass reinforced epoxy resin, and the weight saving which this has made possible by comparison with conventional steel gauges. The gauges are used to check the 108in by 54in panels to $\pm 0{\cdot}010$in lengthwise and $\pm 0{\cdot}005$in crosswise; the steel type weighs 1586 lb, whereas the reinforced epoxy gauge only weighs 196 lb, with obvious advantages from the point of view of handling.

Several examples of much more sophisticated measuring techniques were exhibited in the metrology section which possesses, among others, a Moore universal measuring machine. This machine, believed to be the only example of its type in the country, has a table movement of 18in with a guaranteed maximum error of the master lead screw of 0·000,035in in the 18in of travel and 0·000,015in in any 1in. Crosswise movement of the table is 11in, normal readings being taken to 0·000,02in and with the use of the electrical zeroing instrument repeatable to 0·000,01in. The standards room includes a Hilger-made N.P.L. gauge interferometer capable of absolute measurements of up to 4in and having a determination within 0·000,001in.

A number of items of more general interest were exhibited by the "A" Vehicles Branch.

Fig. 3—Quality assessment group: strip inspection of a "Ferret" Mark II Scout Car (F.V.701)

They included a demonstration of a fully suppressed ignition system and the difference between the much more stringent requirements of military installations and civilian ones. These requirements result not only from the proximity in which wireless equipment is located in military vehicles to the source of interference, but more recently also the introduction of frequency modulated sets which might capture the stronger interference signal and thus cause a break in wireless communication.

Inspection of armoured fighting vehicle optical equipment was illustrated, among others, by the fire control system of the "Conqueror" heavy gun tank (FV.214). This system, which is believed to have been exhibited in detail for the first time, includes a split-image coincidence-type range finder, which is fitted in a fire control or commander's turret mounted in but capable of rotating independently of the main gun turret. The "Conqueror" is the only British tank provided, so far, with a range finder and its optical base is shorter than that of the range finders used for several years in American tanks, such as the M47 and M48 medium tanks, where the range finder is fitted in the main turret. However, it is interesting to note that the U.S. Army has now also adopted coincidence-type range finders, although of a somewhat different design than that of the "Conqueror," in place of its earlier stereoscopic types. The stereoscopic range finders were originally adjudged in the United States to be superior to the coincidence types, but they were found to require an inordinate amount of time for the training of operators, as well as presenting some difficulty in their selection.

Fig. 2—Quality assessment group: in the foreground, dismantled engine transmission and steering gear of a "Ferret" Mark II Scout Car (FV.701)

Commissions in Naval Engineering

To meet a growing need for qualified technical officers in the Royal Navy there has been introduced a direct graduate entry into the Engineering specialisation. The commissions offered are on the General List, which offers the opportunity of promotion to the highest ranks.

Until now the only avenue to a General List commission direct from civilian life, has been via the Dartmouth cadet entry between the ages of seventeen and nineteen. Under the new scheme university graduates with suitable engineering degrees or degree equivalents, up to the age of twenty-five years, may be awarded General List commissions in naval engineering. Officers entering the Navy under the scheme will serve within the new technical officer structure created by the recent amalgamation of the Engineering and Electrical specialisations into a single "Engineering" specialisation. Under the amalgamation, which becomes effective on July 1, 1961, Engineer officers, both mechanical and electrical, will serve together in one of four groups within the Fleet (Marine Engineering, Weapons and Radio Engineering, Submarine Engineering or Air Engineering). This fusion of the Navy's technical officers, with its emphasis on functional rather than—as in the past—professional lines of employment, is designed to produce engineers of wide knowledge and experience, able to fill appointments not limited to a single engineering science.

Applicants should possess degrees in mechanical or electrical engineering (or science with suitable engineering subjects) of a recognised university, or degree equivalents. They should also, wherever possible, have six months' works experience, including that gained during university vacations. Entries will be made once a year, in September. Successful candidates will enter as Acting Sub-Lieutenants. After short introductory courses and sea training lasting about a year, officers will go to various naval specialist schools for professional application courses lasting a further twelve to eighteen months. Officers will be confirmed in the rank of Sub-Lieutenant after ten months and promoted Acting Lieutenant eighteen months after entering the Royal Navy. Confirmation in this rank follows on the satisfactory completion of training. Promotion to Lieut.-Commander is attained after eight years' seniority as Lieutenant. Advancement to Commander and higher ranks is by selection, in competition with other General List officers.

Toroidal Two-Stroke

A positive-displacement internal combustion engine, which is rotary to the extent that the pistons move in circular arcs relative to the cylinder block, has been built in the form of a twelve-cylinder two-stroke ; it offers the possibility of greatly increased swept volumes within a given envelope.

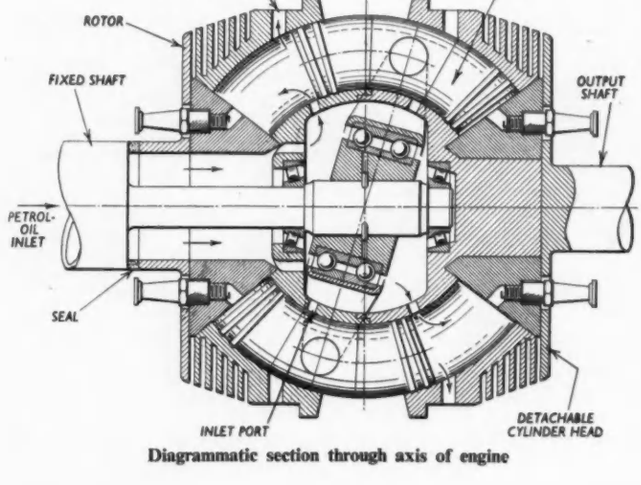
THE two-stroke engine is adopted where small size and weight are important, not so much because of its advantage in mean effective pressure as because the absence of valve gear allows high speeds to be achieved with safety. In order to exploit this advantage to the full, a multi-cylinder two-stroke has been designed by Mr. Cecil Hughes of Engineering Designers (Salisbury), Ltd., in which the stresses due to reciprocation of the pistons have been eliminated by adopting the principle of the rotary cylinder block ; however, instead of the cylinders being radial and eccentric to the piston centre, as in the classical rotary engine, the axes of rotation of cylinders and pistons are inclined and the cylinder bores are arcuate. The working spares are therefore toroidal ; as in the recently disclosed design of Mr. Granville Bradshaw, but instead of there being one continuous space divided up by the pistons there are a number of separate spaces each traversed by one double-acting piston. Although the cylinder bores are at right angles, rather than parallel, to the centrifugal force on the pistons, the centrifugal forces are taken by a piston locating mechanism as in an orthodox engine, since the exhaust ports are naturally located in the outer wall of the cylinder. A fundamental advantage realised by the use of the rotary configuration is that variable port timing can readily be achieved ; in particular an adjustable baffle or shroud can be placed outside the rotating cylinder block to close off the exhaust ports at the point where scavenging is complete and thus allow supercharging.

The principle of the engine can be followed by reference to the illustrations. The cylinder block rotates about the axis of the engine, but the pistons rotate around a large ball bearing inclined to the axis in the manner of a swash plate. The cylinder bores lie, of course, in radial planes in the cylinder block, and hence the angular velocity of the pistons is not constant ; since the pistons are arranged in pairs separated by π radius, the resulting out-of-balance is a couple, dependent for its magnitude on the number of pairs of pistons. The pistons are carried on the ball bearing by a spider ; one pair of pistons are ball-jointed to the spider, and the remainder have freedom to move tangentially to the spider. It is, clearly, necessary to design so that the radius of the circle described by the pistons remains the same at all temperatures encountered in operation as those of the circle defined by the cylinder centres in the plane of symmetry of the block and the arcs forming the cylinder centre-lines.

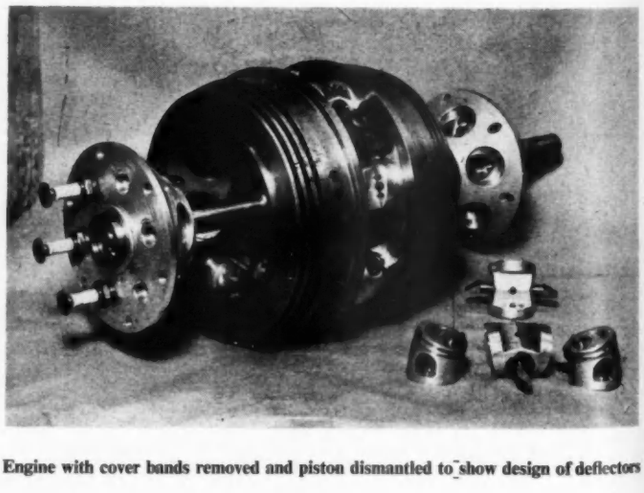
While the centrifugal forces on the pistons are exerted by the spider, and the gas loads are taken out by the spider, the cylinder walls act to control the velocity and the attitude of the piston. There will be a force on either the leading or the trailing face of the piston imposing the changes in angular momentum that the piston experiences in each revolution, and there will also be a couple on the leading face at one end and the trailing face at the other due to the precession moment evoked by the moment of inertia of the piston ; clearly the first will be a maximum at the ends of the stroke and zero at the centre, and for the second the converse will be true.

As is customary in rotary engines, the charge is fed in along the axis of the cylinder block. Spark ignition is simply provided, the engine acting as its own distributor, but fuel injection would present obvious difficulties and the use of a carburettor and petroil lubrication is a natural choice. There is, of course, no fluctuation in the volume of the swashplate chamber and scavenging must be effected either by using some of the working spaces as air pumps, involving either automatic valves or a rotating port plate analogous to a rotary inlet valve in a stationary engine, or by a blower separate from the engine proper.

The design has been adopted and a prototype engine made by William R. Selwood, Ltd., Chandler's Ford, Southampton, Hants., by whom the engine is termed "Orbital." This prototype is seen in our photographs ; it has three pairs of cylinders, i.e., six pistons and twelve working spaces. It has a total swept volume of 700 c.c., so that the individual cylinders are small and heat transfer problems are avoided. The engine is designed so that the "hot" parts can be removed without dividing the cylinder block, which is split on the plane of symmetry ; this is achieved by leaving a broad belt around the "equator" open, to be closed by a separate cover plate assembly, and making each piston in three parts. The spider also is made up with each of the chordal members that restrain the pistons separate, so that by detaching this member and freeing the piston heads which are held by socket screws,



Diagrammatic section through axis of engine



Engine with cover bands removed and piston dismantled to show design of deflectors

the piston centre section can be removed. The cylinder block is made of steel and the pistons and cylinder heads of aluminium alloy. Each piston head carries two rings of conventional cylindrical shape which are, naturally, pegged ; it has been observed that after 300 hour's running the rings were noticeably adapting to their toroidal chamber and it is estimated that 1000 hour's running would bring them to seating over the whole of their outer surface. With the exception of available proprietary items such as bearings and piston rings, the entire engine was made in the works machine shop, and we are advised that it achieved trouble-free operation with no modification whatever.

The prototype, and only, engine has been demonstrated to us. It started readily on being spun with a cord round a pulley, with a momentary flash of flame from the exhaust belt, and then settled down to run light with the marked steadiness associated with rotary engines. As is expected with piston-ported engines, the exhaust note had a quality of sharpness, while on a mixture of 16 : 1 petrol : oil the exhaust was clearly visible. It was noticeable that when the ignition was shut off the engine stopped rapidly, although this example has a low compression ratio, indicating that while the momentum of the engine is relatively high so too is the swept volume.

The possibility of masking the exhaust port for part of the interval between outer dead centre and inlet port closing—and, obviously, the whole of that between inlet port closing and exhaust port closing—by means of a simple shroud opposite the exhaust belt which can be moved to allow only the desired degree of scavenging has been demonstrated on this installation, which has a Wade helical port blower ; at a fixed throttle setting, moving the shroud to effect supercharging increased the speed from 3000 r.p.m. to 3500 r.p.m. and the torque by 35 per cent. It should be recorded that observations of torque and of efficiency of the prototype remain undisclosed, since it has a very low compression ratio and does not give a performance representative of a developed engine.

The prototype has, we are advised, proved virtually viceless in test-bed running ; to a certain extent this may be attributed to the large number cylinders, which will tend to mask four-stroking or failure to fire. However, when the engine was opened up after a short run on zero load, we observed that all the plugs, Lodge "CN," appeared to have been running in the self-cleaning temperature range, although two seemed slightly moist.

The potentialities of the new engine have yet to be determined. Its applications would seem to be limited to those where it is desired to run an engine at high speeds in order to minimise the weight and bulk of the engine ; however, the design of the combustion system is naturally more difficult at high speeds, and the new engine imposes the further obstacle that the disposition of the ports is circumscribed by the arrangement of the cylinders in a circle. The development of a suitable combustion system is also likely not to be facilitated by the need to monitor pressures and temperatures on a rotating body, though of course it may prove that the aerodynamics and thermodynamics are unaffected if the cylinders stand still and the shaft rotates, which would be more convenient for development work. In the same context it may be remarked that diagnosis and tuning in service will depend on the use of electronic engine test gear and the provision of a timing pulse to allow individual cylinders to be identified. While higher speeds may be realised, the particular promise of the rotary engine is the simple variable timing which allows running normally aspirated to be the part load case; however, it would appear almost inevitable that the exhaust ports will be in a belt of cooling air at a pressure above atmospheric. Both the speed and the torque of the two-stroke are, it is acknowledged, often limited by the tolerable exhaust port temperatures, and it would seem that in an engine that is essentially air cooled this limitation is likely to be pronounced.

Both heat transfer problems and the need to support the pistons against centrifugal force with consistent accuracy may hold down cylinder size, although since this is essentially a multi-cylinder engine this restriction may not be severe—an 8-litre engine which has been projected should have a power of the order of that at which gas turbines become competitive. The production of the engine is hardly likely to prove cheap, since each cylinder bore would have to be machined separately and the tools could be allowed only a very narrow contact on the curved surfaces. The advantages of compactness and light weight are therefore likely to be offset by cost, noise, and poor fuel consumption at low load ; even so there are clearly some promising applications, such as capacity-class motor racing and portable fire pumps or contractor's plant.

Cable Repair Ship "Retriever"

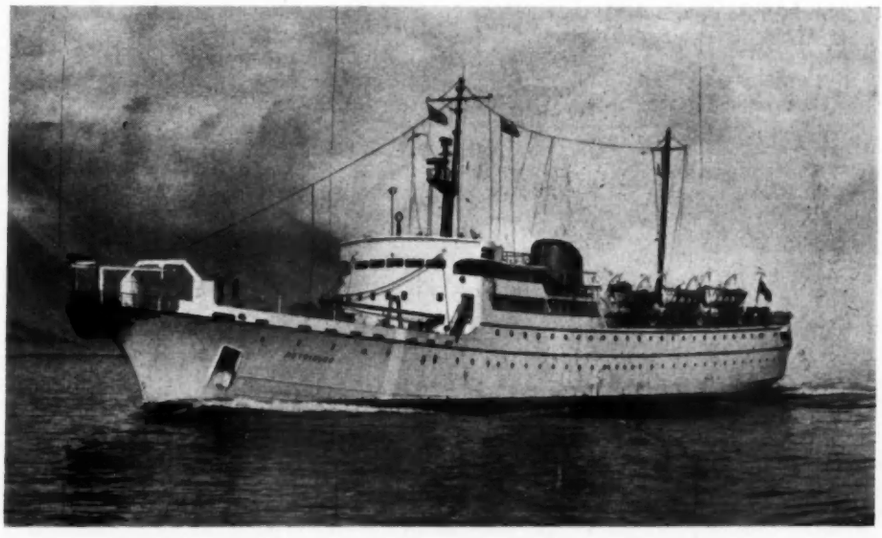
The latest unit to join the fleet of Cable and Wireless, Ltd., is cable repair ship "Retriever," which has been specially designed to handle coaxial telephone cables with submerged repeaters inserted. The ship has a gross tonnage of 4000, *an operating range of* 8000 *miles and a cable capacity of* 21,000 *cubic feet. Propulsion is by diesel-electric machinery, consisting of two propulsion motors of* 3300 *total s.h.p. supplied with power by four diesel-driven generators.*

THE latest addition to the fleet of Cable and Wireless, Ltd., is the C.S. "Retriever" which is the fifth ship of that name to be owned by the company, the first being built as long ago as 1878, the second a year later, while the third was completed in 1909 and sunk by enemy action in 1941. Ship number four was originally the Admiralty cable repair ship H.M.S. "Bullfrog" and was acquired in 1948 and renamed "Retriever." The new ship, seen on trials in our illustration, has been built, to the plans and specifications prepared by the owners technical staff, by Cammell Laird and Co. (Shipbuilders and Engineers), Ltd., and has recently completed "shake down" cable trials off the Scillies and the Irish Coast. Operational experiences of senior officers of the owners' fleet have been incorporated, together with modern developments, in the design of the ship, which is the company's first ship, to be designed for the recovery and overboarding of coaxial telephone cables, with submerged repeaters inserted, in any depth of water. After loading cable the ship is expected to sail from Southampton towards the end of May for Manahawken, New Jersey, to commence laying the shore ends of the new telephone cable between New York and Bermuda. This cable will have submarine repeaters inserted and will carry eighty telephone conversations simultaneously. After the completion of this task C.S. "Retriever" will be based on Gibraltar and will be stationed eventually at Suva to maintain cables in that area.

The main particulars of the ship are :

Length between perpendiculars	330ft 0in
Breadth moulded	47ft 6in
Depth moulded to upper deck	29ft 6in
Summer draught	19ft 0in
Deadweight	2750 tons
Gross tonnage	4000 tons
Trial speed	15 knots
Steaming range	8000 miles
Main machinery :	
Two 1650 s.h.p. electric motors	3300 s.h.p.
Two 772kW diesel-driven generators	
Two 560kW diesel-driven generators.	

Of mainly welded construction the ship has two continuous steel decks, main and upper, and a cellular double bottom subdivided into tanks for the carriage of ballast and oil fuel and incorporating a duct keel extending from the engine-room to the forward hold. There are three cable tanks having a total capacity



Cable repair ship C.S. "Retriever" on trials

of 21,000 cubic feet and equivalent to 420 miles of conventional deep-sea cable. A large hold and a 'tween deck space are provided forward, for the stowage of cable equipment, and are served by two 5-ton derricks mounted on the bridge front and operated by two hydraulic winches. To port and starboard on the upper deck and abreast of the hatch to the hold are trawler pattern gallows cranes, for lifting buoys out of the water, and each has a safe working load of 8 tons.

The cable machinery, of which we give a general view, was supplied by Johnson and Phillips, Ltd., and is arranged on the main and upper decks forward ; it consists of two sets of electric hydraulically operated cable picking-up and paying-out gear associated with port and starboard sets of sheaves and cable drums. The cable drums, lead sheaves and bow sheaves are of 7ft diameter and there is a gantry arranged over the bow sheaves for the overboarding and recovery of rigid repeaters. The drums are overhung towards the centre line of the ship and project through a hatchway at the upper deck where hauling-off and holding-back units are mounted aft of the hatch. Each of the machines is powered by a 175 h.p., 220V, d.c., 480 r.p.m., constant-speed motor coupled to a hydraulic pump and to two hydraulic motors fitted with tilt box speed controls. These motors are coupled to two-speed gearboxes and have sliding pinions which mesh with the internal gear wheels of the main brakes and cable drums; furthermore the drives are interconnected hydraulically so that either motor can drive the port or starboard equipment.

For picking-up, the drive is by the 175 h.p. motor and hydraulic units through a fixed gear train to the cable drum and the unit is rated to handle loads up to 30 tons at 50ft per minute reducing to 7½ tons at 200ft per minute. The hydraulic motors are automatically converted to hydraulic pumps, for paying-out operations, and are able to absorb up to 450 b.h.p. through a fixed pressure relief valve system. On this duty the machinery is able to deal with loads up to 8 tons at 800ft per minute. Tilt box controls regulate the speed of picking-up or paying-out. The hauling-off and holding-back unit at each machine controls the varying tensions, forward of the cable drum, and are independently braked or driven. Hydraulic pattern combined lead sheave and load cell dynamometers have master and repeating dial gauges at the bow sheaves, cable gear control position, the testing room and the wheelhouse. There is also a graphical recording instrument fitted in the test room which records the strains when paying-out or picking-up cable.

The deck machinery, which is hydraulically operated from electrically-driven pump units, was supplied by Vickers-Armstrongs (Engineers), Ltd., and consists of two warping and cable capstans forward on the upper deck with power units below on the main deck ; two winches on the upper deck forward of the bridge ; and one warping capstan aft on the upper deck with the power unit sited below in the steering gear compartment. Brown Brothers and Co., Ltd., manufactured the two-cylinder electro-hydraulic steering gear and also the Voith-Schneider propeller which is mounted in an athwartship tunnel, below the light load line, in a forward compartment to give a side thrust of 2 tons and so give the ship a high degree of manoeuvrability. There is a comprehensive set of navigation equipment in the wheelhouse where there is also fitted a console which incorporates main engine and Voith-Schneider propeller controls the Brown steering column, watertight door controls, and Chadburns electric "Synchrostop" telegraphs and vernier common speed and differential controls to provide infinite speed variation of the motors to suit the requirements of cable repair operations. It is also possible to control the ship from port and starboard positions at the bow.

The whole of the accommodation is air conditioned using the "Hi-press" system, provided by Colvinaire, Ltd., with individual control in each cabin. Besides providing suites for the captain and chief engineer the deckhouse forward on the bridge deck includes the officers' dining room and lounge. Deck, electrical and engineer officers have their cabins arranged on the upper deck to port and starboard of a wide central working alleyway which runs forward and aft and is essential for the handling of repeaters and to allow cable to be passed from the cable tanks forward over the bow sheaves or aft over the stern chute. The cabins are cut off from the working spaces and are also set in from the ship's side, access to the various cabins being by a passageway along the side of the ship. This particular arrangement means that the cabins are not subjected to the direct effect of tropical heat and that shell repairs can be effected without disturbance of the accommodation. Seamen and engine-room ratings have two berth cabins aft on the main deck, while mess spaces and galleys are arranged amidships. All cabin and divisional bulkheads and linings are of plastic faced non-combustible "Marinite." For life-saving purposes there are four lifeboats of reinforced plastic, one being motor driven, and also a motor launch and motor cutter for cable work, all built by Lambie (Wallsend), Ltd., and carried in Welin MacLachlan davits. In addition there are six ten-man inflatable liferafts.

Machinery

Propulsion is by twin screws, each powered by a 750V d.c. electric motor having a continuous rating of 1650 s.h.p. at 144 r.p.m. and an astern power of 80 per cent of the ahead. These motors, placed aft of No. 3 cable tank, are arranged in a series sandwich loop so all or any one generator can supply both motors. The propeller shafts are carried in Michell bearings and the tail shaft couplings permit the withdrawal of the tailshaft through the stern tube. Power for the main motors is supplied by four diesel-driven generators; the two inboard sets each consist of a 772kW d.c. generator driven at 450 r.p.m. by a Mark 5 SRLM diesel engine of 15in bore by 20in stroke and pressure charged. Each outboard generator set is powered by a Mark 5 CSRLM engine which is turbo-charged and after-cooled and drives a 560kW main d.c. generator at 450 r.p.m. and a 450kW auxiliary generator in tandem. The latter provides auxiliary power at sea, while for services in port there are two 300kW generators, each driven by a Mark 6 SRKM diesel engine which is turbo-charged and has a bore and stroke of 10in by 12in. The propulsion machinery was manufactured by the English Electric Company, Ltd. and this company also provided the control board.

There are two Worthington Simpson air-cooled air compressors, one electrically driven and one diesel driven. All circulating and transfer pumps were manufactured by Drysdale and Co., Ltd., and these include three 130 tons per hour and three 30 tons per hour salt-water/fresh-water circulating pumps ; one 24 tons per hour diesel oil transfer pump ; one 4·5 tons per hour lubricating oil transfer pump ; one 30 tons per hour general service pump ; and two 70/46 tons per hour bilge and ballast pumps. De Laval purifiers are installed for dealing with lubricating and diesel oils and there are Megator pressure sets for domestic water services, while for the various heating duties there is an oil-fired, automatically-controlled Spanner " Swirlyflo " vertical multitubular packaged unit having an evaporation rate of 1800 lb per hour at 60 lb per square inch.

General view of cable gear looking forward

Birmingham–Preston Motorway

A CONTRACT for building a further 15 miles of the Birmingham–Preston Motorway (M6) in North Cheshire has been let. This section lies just south of the Thelwall viaduct, and is to be built by Tarmac Civil Engineering, Ltd., for a contract price of £8,635,674. The work will be completed within twenty-seven months. The roadworks have been designed for the Ministry of Transport by the Agent Authority, Cheshire County Council (county surveyor and bridgemaster, Mr. C. G. Day). The bridgeworks have been designed by Messrs. Scott and Wilson, Kirkpatrick and Partners, consulting engineers.

The whole 78 miles of motorway between Dunston, north of Birmingham, and Preston will soon be under construction. The lengths in Staffordshire and Lancashire have already been started (see THE ENGINEER, February 10 last), and the only remaining section is that in South Cheshire (between the Staffordshire–Cheshire border and the A.54 at Holmes Chapel) for which tenders are under consideration. It is hoped to start work on this section shortly, the Ministry states.

Institution of Locomotive Engineers

THIS year marks the fiftieth anniversary of the founding of the Institution of Locomotive Engineers, which was celebrated by a golden jubilee luncheon in London last week. A special exhibition of rolling stock covering the latest forms of railway motive power was arranged by the British Transport Commission as part of the celebrations and the arrangements included an all-day tour of the West Country. At the luncheon the President, Mr. D. C. Brown, spoke of the way in which the Institution's influence had extended and its prestige had grown at home and in overseas countries since it was established fifty years ago by eight founder members. Referring to the modernisation plan of British Railways, Mr. Brown said the fund of experience being acquired, particularly in connection with diesel and electric locomotives, would prove of inestimable value to railway engineers in all parts of the world.

In proposing the toast of the Institution Mr. Ernest Marples, the Minister of Transport, made an assessment of the railway problem in this country as he saw it. Railways, he said, were a national possession of the greatest value and in a highly industrialised country such as this an efficient distribution link was essential between producers and consumers; that was why the Government had made it clear that it saw a continuing future for a railway system. That system, however, must be efficient and justify the amount of money being spent on its modernisation—£140 million this year.

To ensure that railways play their proper part it was necessary to ensure that the public money invested in them was justified—at present they received an annual subsidy of over £100 million—and it was necessary for the minister to concern himself very closely whether individual schemes would be economically justified. Having produced the required amount of money and used it in the best ways it was then necessary to see that the railways were free to use their assets without being fettered by obsolete restrictions. The Government had announced its intentions of removing the main restrictions under which the railways suffered, but the railways must help by getting, holding and increasing their carriage of the right traffics.

A high technical performance was required on railways to this end and Mr. Marples said that this requirement was of particular interest to the institution. Research and development could help and plans were being discussed for improving and enlarging the British Transport Commission's organisation for research and development and for increasing the scientific staff. A difficult problem to be overcome was the decision as to the right size and shape of the railway system in this country, and some progress was being made in this direction. Mr. Marples concluded by saying that the Government had already produced £600 million for modernising the railways and, providing it was justified, more money would follow.

The Sir Seymour Biscoe Tritton lecture was given this year by Sir Brian Robertson, who dealt with the locomotive of the future. He said that if the railways were to stand up to the increasingly fierce competition from road and air, locomotives must be designed for speed and the utmost reliability. It was not enough that a locomotive should be capable of hauling trains of given weight to specified time schedules, it must also be capable of doing this very reliably over the years at low cost. It was the clear responsibility now of the locomotive engineer who designs a diesel or electric locomotive to ensure freedom from trouble and an ability to remain in traffic for days on end without attention.

The present initial cost of a high-powered main-line diesel locomotive was from three to four times that of a steam locomotive of corresponding power. In Sir Brian's opinion this was too dear, as in this small island it was not possible to arrange the schedules so as to ensure that every main-line locomotive did a sufficient annual mileage to justify such a high price. British industry had only in the last few years had an opportunity to carry out large-scale manufacture of high-powered diesel locomotives. Electric locomotives suitable for the 50 cycle a.c. system were also a new requirement. Under these circumstances a rather high cost was understandable, but he suggested that, with experience now behind them, manufacturers should give very serious consideration to the question of reducing the cost without sacrificing the quality.

The locomotive of the future must be capable of rapid acceleration, consistent high running speed, and effective braking. Recent difficulties in maintaining punctuality had compelled the operating staffs to allow more recovery time in the timetables, and this had produced a doctrine that a few miles an hour of additional speed were not worth the trouble and expense involved. Whilst agreeing that punctuality was essential and that it was possible to pay too dearly for a small increase in speed, Sir Brian was sure that speed was very important as when many passengers were making their choice of transport, a difference of fifteen minutes could very well decide their choice.

British Railways had come in for a lot of criticism on the score of unpunctuality and anybody who understood the railways knew that the causes of unpunctuality were legion, but there was one cause for which the cure lay with the locomotive engineer. A very high proportion of steam locomotives to-day were being worked to the limit of their capacity with little or no reserve in hand. It was a very great advantage of electric traction that the current available to the catenary provided in itself a reserve of power which could be drawn upon heavily, at least for a short time. Diesel locomotives, on the other hand, must not be overloaded, and they must therefore have something in reserve on which they could draw when conditions were adverse and they got behind schedule. Sir Brian said that when they embarked upon the modernisation plan the British Transport Commission was apprehensive about the reliability of high-powered main-line diesel locomotives. Experience to date had been rather uncomfortable, and the Commission was aware that railways in other countries had encountered a considerable amount of trouble when they first embarked on a plan of dieselisation. He was glad to be able to say now that the decision to have confidence in British engineers and manufacturers to turn out locomotives that would not involve the railways in a sea of troubles had been justified. The standard of performance of British main-line diesel locomotives, taken as a whole, did them much credit, although there was still room for improvement.

A high proportion of the troubles experienced related not to the main items of equipment such as the engine, main generator or traction motors, but to piping, tubing, gauges, electric connections, plumbing generally, and to the train heating equipment.

Of electrification, Sir Brian said that British Railways had adopted the 50 cycle, 25kV, a.c. system after careful thought. It was possible to argue that a d.c. system of lower voltage would have been quicker and easier but he was satisfied that the decision taken was a right one, and certainly the a.c. system was practically the only one saleable to-day in the export market. It was admittedly a new system and in several cases fairly serious initial troubles had been encountered. In paying tribute to those who had been concerned with the work on these systems, including manufacturers who had been contractors, Sir Brian said it was easy for the critics to say that these troubles should have been eliminated by previous experiment and test. The history of railway engineering gave evidence, however, that revolutionary changes of this kind never revealed all their problems until the system was put into full working service. It was forgotten now that when the Southern Railway opened its new electrified services there was a considerable amount of trouble and a lot of criticism. These difficulties were overcome quickly and the work then carried out under Sir Herbert Walker had been a boon ever since to the travelling public.

Sir Brian was sure that no trouble which had developed on the new services could be described as basic and could not be quickly overcome. Moreover, the experience which all had gained, including the contractors, was such as to put them in the lead in this form of engineering—they had learnt and discovered things which had been unknown before.

Sir Brian Robertson concluded by saying that he would like to see British locomotive engineers collaborating even more than now in research, development, and test. He would like the locomotive industry to have something corresponding approximately to the facility which M.I.R.A. provides for the motor vehicle industry.

Rolling Stock Exhibition

An exhibition of locomotives and rolling stock was arranged by the British Transport Commission as part of the Golden Jubilee celebrations and held at Marylebone Parcels Depot on May 10, 11 and 12, after which it was open to the public for two days. The exhibition was visited by the Duke of Edinburgh on May 12.

Three locomotives not previously exhibited were the first of ninety-five "Hymek" diesel-hydraulic units for the Western Region, the English Electric prototype 2700 h.p. gas turbine locomotive, and one of the production series of twenty-two English Electric "Deltic" 3300 h.p. diesel-electric locomotives. The "Hymek" locomotive, built by Beyer, Peacock (Hymek), Ltd., is the first diesel-hydraulic in the British Railways type 3 power classification. A 1700 h.p. Bristol Siddeley Maybach engine drives through a Stone/Maybach "Mekydro" K184U transmission comprising a torque converter and self-changing mechanical gearbox. Next to this exhibit was the English Electric 2700 h.p. gas turbine prototype with mechanical transmission, the final drive being taken from a frame-mounted reversing gearbox through a pinion, gearwheel and flexible linkage to the centre axle of the three-axle coupled wheelbase. This locomotive is due to be shedded at Leicester and begin revenue-earning service with a daily passenger train return trip between Marylebone and Nottingham.

LETTERS AND LITERATURE

Letters to the Editor

MILLIONS TO BE SAVED?

SIR,—In your issue of April 21, Mr. H. H. Anderson wrote in favour of elevated roads above the railways. To keep my reply short I make two, possibly derisible, assumptions. They are for the purposes of this letter only; by imagining them valid one can arrive at a starting point from which Mr. Anderson may care to carry the banner of roads-above-railways on into the labyrinth of this country's transport affairs.

My first assumption will be that transport is a matter of economics, not politics. Curiously British scholarship in transport economics is of a high standard: a lot of devoted work has gone into the subject. The 1954 edition of the Cambridge handbook stated, fatefully, that to take certain measures "to protect past investment is not to prevent but to aggravate waste." Three or four years later in the railway modernisation era, the British Transport Commission (with other bodies) generously set up a readership in the subject at Oxford; from the new oracle there come works of equal erudition. But it is to the works of our world-renowned Road Research Directorate that I would draw Mr. Anderson's attention, more particularly to Technical Paper No. 48 of June, 1960. These works would soon convince him that there must be very few routes in Britain on which it could be worth spending about a million pounds a mile. Col. Lovell's figure for road-above-rail was £800,000 per mile many years ago.

It happens that my second assumption has already been adopted by Mr. Anderson, though he was very casual about it: he simply wrote, "The existing railways belong to the nation." Part of the nation, living in Norfolk, have found otherwise: they are being asked to pay some £10,000 per mile before taking possession of what belongs to them! In evidence submitted to the Parliamentary Select Committee (page 388), B.T.C. revealed that "the estimated realisable value of branch lines in rural areas is taken at £60 per mile in England and £30 per mile in Scotland"; but the Commissioners are all-powerful and can tell a very different story when the disused line threatens to become a road that would compete with the surviving railways, as in Norfolk. Again, in expectation of roads being constructed above the railways, one of the Commissioners has written, "on principle shall we compute scores of millions to be paid by the upper storey tenant to the owner of the ground floor?" (a British Association paper, September 8, 1959, para. 5.41). Our assumption will therefore be of particular value to Mr. Anderson; it cuts out all shylockian complications, and enables us to ignore the past, starting with a clean sheet when we tabulate the economics of the various projects. The accompanying table sets the matter out, so far as we have gone, using the further assumption, that, after modernisation, B.R. will comprise 16,600 route-miles, and the process will therefore have cost an average of £100,000 per mile, ranging from nil to £200,000 per mile.

Per route-mile	British Railways		Road above rail	Convert into road
	Old-style	Modern		
	£	£	£	£
Fresh capital required...	Nil	200,000	900,000	30,000
Annual capital charges at 6 per cent p.a.	Nil	12,000	54,000	1,800
Annual maintenance ...	6,000	8,000	7,000	1,000
Annual cost, accordingly	6,000	20,000	61,000	2,800
Capitalised liability at 6 per cent	100,000	333,000	1,016,000	47,000
Capacity, relative	1	2	21	20
Cost per annum per unit capacity	6,000	10,000	2,900	140
Capitalised liability at 6 per cent, per unit capacity	100,000	167,000	48,500	2,330

T. I. LLOYD

Guildford,
May 7, 1961.

METROPOLITAN LINE WIDENING

SIR,—I think that London Transport would need to save many more than one £150,000 train to justify the cost of the fourth track between Moor Park and Harrow and, to be really convincing, they would have to show how it was to be done.

The rest of the reasons given for not adopting the three-track system, with one track reversible, can for the most part be classed under the general heading of "Operational difficulties," a phrase which has long ago fallen into disrepute on the lips of station announcers by too frequent repetition. However, the money has mostly now been spent and Mr. Robbins tells us that London Transport carefully considered and rejected the three-track scheme during the planning of the works—in this he is no doubt correct.

He said that one of the reasons for the rejection was that the scheme would require flyunders at Harrow North and Watford South junctions, and in this way rather spoiled the effect. It so happens that at Watford South junction the line runs over the Grand Union Canal and a flyunder at this point would seem to land the trains inevitably in the canal! This would, I fear, be more productive of the bad language traditionally associated with these waterways than of the increased line capacity which it was designed to ensure.

E. J. R. KAY

Rickmansworth,
May 4, 1961.

Book Reviews

Introduction to Modern Network Synthesis. By M. E. VAN VALKENBURG. John Wiley and Sons, New York. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 94s.

"Analysis" and "synthesis" are everyday words which are used in a wide variety of contexts. When applied to electrical networks they have specific meanings. They are best explained and defined by examining the basic function of a network: the production of a response at the output when an excitation is applied to the input. The determination of the form of the response when the excitation and the network are given is "analysis"; the specification of the network when the excitation and response are given is "synthesis." Although in both cases it is a question of finding one unknown out of three when two are given, there is a fundamental distinction between the two processes. In analysis there is a unique solution; in synthesis there may be any number of solutions—or there may be no solution. Network analysis lends itself to straightforward, although possibly difficult, mathematical treatment for finding the sole solution to a specific problem. Network synthesis, although no less mathematical, calls more for an engineering approach to the problem. This can be seen by considering the possible stages in obtaining solutions to a network synthesis problem. First of all the requirements of the network to be determined must be specified. In specifying these parameters the question of the permissible tolerance that can be accepted is involved. It is frequently both impossible and unnecessary to satisfy the requirements exactly, so that approximations must be brought in. The solutions take the form of the realisation of physical networks whose response meets the approximated specifications. A choice must be made between a number of alternative solutions and other criteria, such as cost, availability, and suitability of components, must be taken into account. Other lines of approach to the synthesis problem will call for, in some degree, the engineering attributes of specification of requirements, stipulation of tolerances, approximation and judgment.

In the first chapter of his book Professor Van Valkenburg brings out all these points, and gives a good general account of the problems involved in network synthesis. He then briefly reviews the fundamental network equations that are obtained by the application of Kirchoff's laws, and indicates how they can be solved by means of Laplace transforms. In his second chapter he gives a recapitulation of linear network analysis. This also serves to define the various network functions and to explain magnitude and frequency scaling. Since there may not be a realisable network which gives the required response for the applied excitation, it is necessary to approach the synthesis problem by establishing necessary conditions for the existence of a solution. This calls for a considerable amount of fundamental theory and the next two chapters are devoted to this. Chapter 3 discusses the properties of positive real functions. It follows the methods of Brune who produced the first systematic treatment of network synthesis as recently as 1931. Chapter 4 uses these results and goes on to establish a testing procedure for driving-point functions, introducing the Routh-Hurwitz criterion and the Sturm test. In order to follow the theory that is built up in these two chapters the reader must be proficient in the applications of Laplace transforms and have a working knowledge of other mathematical functions, such as Stieltjes continued fraction.

The first form of network synthesis to be studied is the passive one-terminal-pair network. This is alternatively described as

a one-port network, or sometimes as a two-terminal network. The performance of such a network is specified by its driving-point function. This must be realised by various combinations of resistance, inductance and capacitance which are referred to as *R*, *L* and *C* elements. The synthesis procedures are considered logically in three chapters: one with *LC* elements, one with *RC* and *RL* elements, and one with *RLC* elements. To follow the procedures the reader must be thoroughly familiar with pole and zero manipulations of rational functions and understand such operations as "removal of a pole at infinity." The methods of synthesis, using two of the three elements, fall into two classes: one derived from the partial fraction expansion of the impedance or admittance function; one resulting from a continued fraction expansion. The former are due to Foster who is well known for his Reactance theorem; the latter are based on Cauer's work on ladder networks. The basic canonical forms, that is, the networks containing the minimum number of elements to meet the given specifications, are known as the two Foster forms and the two Cauer forms. For *RLC* synthesis, which is more complicated, the Brune procedure and the methods of Bott and Duffin are given. The former makes use of ideal transformer elements; the latter results of types of bridge networks.

There are two main methods of approach to the problem of two-terminal-pair, two-port, or four-terminal networks, which can be described briefly as *ladder* or *lattice*. Two full chapters are devoted to ladder development giving methods due to Cauer and Guillemin. The following chapter studies the important subject of symmetrical lattice and constant-resistance networks. It includes Bartlett's bisection theorem and the process of lattice decomposition, i.e., the ladder development of the lattice.

In practical applications a network must be coupled to an energy source and to a load. One chapter deals with a network with an ideal current source and a resistive load; another with the more general case where there are terminating resistances at the input and the output, doubly-terminated networks. Darlington's method of synthesis is given and the use of reflection coefficient, or scattering coefficient, is explained. A final chapter explains the methods of synthesis on an image impedance basis, giving the procedures developed by Campbell and Zobel. The design of filters with resistive terminations and the design of composite filters are included. Two chapters, suitably placed in the book, are concerned with the important subject of approximation. In the first, methods are given for finding approximations to frequency-domain quantities. The various kinds of factors that occur in the network functions are considered independently and in combination. In the second the use of Butterworth and Chebyshev polynomials are explained.

This is a book which contains a great deal of mathematics and theory. The author has provided as much assistance as possible by clear descriptions and explanations, many worked examples, an extensive use of tables to summarise procedures and results, well laid out equations, and good diagrams. At the end of each chapter there are references for further reading and a liberal supply of problems. Despite the use of the word "introduction" in the title, this is in no way an easy book. It is however an important one on a topic which has wide applications in modern electrical engineering. As well as having practical applications some aspects of network synthesis can be considered as applied mathematics. Professor Van Valkenburg has succeeded in his intention of following a middle course between theory and application. He has written his book as a textbook for advanced under-graduate or graduate courses and has based his own teaching on its material. Although there has been in recent years a number of textbooks on this subject, notably by United States authors, this one is recommended as providing a good comprehensive introduction and account of the modern methods used in the extensive and multifarious subject of network synthesis.

Michael Faraday : A List of His Lectures and Published Writings. By ALAN E. JEFFREYS, B.A., A.L.A. Chapman and Hall, 37, Essex Street, London, W.C.2. Price 42s.

THE aim of this bibliography of Michael Farady's lectures and published writings is to give a chronological list of his books, papers, articles, letters to the Press and manuscript lecture notes. Its content is confined to matter published in English in Great Britain. As a work of scholarship its great merit is the completeness of the bibliography and of the index, which will help a student to find the references to Faraday's written contributions on any subject. Anyone who is not conversant with Faraday and his work will be surprised at the extraordinary diversity of his interests as revealed in this book.

The bibliography begins with 1816, four years after Faraday went to the Royal Institution as assistant to Humphry Davy, and the opening entry "On The General Properties of Matter" records Faraday's first lecture to the City Philosophical Society, on January 17. The last entry is for 1865, the year before he died, and it concerns "the magneto-electric machine of the Alliance Company" which appeared in Parliamentary papers in correspondence between the Board of Trade, the Lighthouse Boards and other parties. Between these two entries more than 480 items are listed. The range of subject matter is prodigious. As might be expected, many of the entries concern Faraday's historic contributions to electricity, electromagnetism and electro-chemistry. Other entries show some of his many sided interests, For example, there are a number of commentaries on Brunel's work, including his "condensed gas-engine," the tunnel at Rotherhithe and his "new mode of building arches." There are notes on the flowing of sand under pressure and several others on the prevention of dry rot in timber; on the nature of musical sound and on the application of "a new principle in the construction of musical instruments"; on lithography and printing; on the steam jet; and on the glaciers of Switzerland.

Frequent references are found in this book to Faraday's lectures and observations on "mental education." Among the many excellent illustrations there is a picture showing Faraday giving one of his Christmas Juvenile Lectures in 1856, "with the Prince Consort in the chair, accompanied by the young Prince Albert (later Edward VII) and his brother." Another illustration shows, in facsimile, the prospectus of Faraday's first course of juvenile lectures delivered at the Royal Institution "during the Christmas recess" in December, 1827. Equally intriguing is an entry which records that in 1831 Faraday prefaced, and published at his own expense, a pamphlet "'On the alleged decline of Science in England.' By a Foreigner."

But references picked out at random do scant justice to Mr. Jeffrey's book. The author's introduction carefully explains the scope of the bibliography, enumerates in detail the sources of his information and lists the classes of material that he has deliberately excluded. Scholars and historians will find the book an invaluable addition to the literature.

Books Received

Pore Pressure and Suction in Soils. Butterworths, 4-5, Bell Yard, London, W.C.2. Price 60s.

Fuel Research 1917-58. H.M. Stationery Office, York House, Kingsway, London, W.C.2. Price 15s.

Practical Physical Metallurgy. By R. Rawlings. Butterworths, 4-5, Bell Yard, London, W.C.2. Price 30s.

Graphic Statics. By Cyril S. Benson. B. T. Batsford, Ltd., 4, Fitzhardinge Street, Portman Square, London, W.1. Price 25s.

Tables of Elementary Functions. By Mieczyslaw Warmus. Pergamon Press, Ltd., Headington Hill Hall, Oxford. Price 105s.

Atomic Energy Waste. Its Nature, Use and Disposal. Edited by E. Glueckauf. Butterworths, 4-5, Bell Yard, London, W.C.2. Price 95s.

The Calculus of Finite Differences. Fourth Edition. By George Boole. Chelsea Publishing Company, New York, N.Y. Price 1.39 dollars.

Year Book of the Heating and Ventilating Industry, 1960-61. Technitrade Journals, Ltd., 11-13, Southampton Row, London, W.C.1. Price 15s.

Boolean Algebra and its Applications. By J. Eldon Whitesitt. Addison-Wesley Publishing Company Inc., 10-15, Chitty Street, London, W.1. Price 51s.

Management Training Aims and Methods. By R. J. Hacon. The English Universities Press, Ltd., 102,. Newgate Street, London, E.C.1. Price 17s. 6d.

Statistical Theory of Communication. By Y. W. Lee. John Wiley and Sons, Ltd., Gordon House, Greencoat Place, London, S.W.1. Price 134s.

Kinematics and Dynamics of Machinery. By Robert L. Maxwell. Prentice-Hall International Inc., 34-36, Beech Street, London, E.C.1. Price 45s.

The Structure of the Atom. An Electromagnetic Theory by Harry Melville Dowsett. Stephen Austin and Sons, Ltd., Caxton Hill, Hertford. Price 30s.

Field Computations in Engineering and Physics. By A Thom and C. J. Apelt. D. Van Nostrand Company, Ltd., 358, Kensington High Street, London, W.14. Price 30s.

Warehouse Operations Planning and Management. By Andrew J. Briggs. John Wiley and Sons, Ltd., Gordon House, Greencoat Place, London, S.W.1. Price 68s.

Introduction to Natural and Synthetic Rubbers. By D. W. Huke. Hutchinson and Co. (Publishers), Ltd., 178-202, Great Portland Street, London, W.1. Price 25s.

Progress in Cryogenics. Vol. 3. Edited by K. Mendelssohn. Heywood and Co., Ltd., Carlton House, Great Queen Street, London, W.C.2. Price 45s.

Continuous Casting of Steel. By M. C. Boichenko. Translated by L. Herdan and R. Sewell. Edited by G. Fenton. Butterworths, 4-5, Bell Yard, London, W.C.2. Price 50s.

Technical Optics. Vol. II. Second Edition. By L. C. Martin. Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2. Price 63s.

Photoelasticity Principles and Methods. By H. T. Jessop and F. C. Harris. Dover Publications, Inc., 180, Varick Street, New York, 14, New York. Price 2.00 dollars.

Statistical Theory and Methodology in Science and Engineering. By K. A. Brownlee. John Wiley and Sons, Ltd., Gordon House, Greencoat Place, London, S.W.1. Price 134s.

Transistor Circuit Analysis. By the late Maurice V. Joyce and Kenneth K. Clarke. Addison-Wesley Publishing Company Inc., 10-15, Chitty Street, London, W.1. Price 81s.

Principles of Transistor Circuits. Introduction to the Design of Amplifiers, Receivers, and Other Circuits. By S. W. Amos. Iliffe Books, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 21s.

Graded Exercises in Technical Drawing for Secondary Schools. (Students' Book). By W. G. Beetles. Hutchinson Educational, Ltd., 178-202, Great Portland Street, London, W.1. Price 10s. 6d.

Radio and Electronic Components. Vol. V: *Wires and R.F. Cables.* By G. W. A. Dummer and W. T. Blackland. Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2. Price 47s. 6d.

The Royal Society's Conversazione

THE Royal Society held its annual conversazione at Burlington House, London, on May 11. Of the twenty-eight exhibits a number were of direct interest to engineers and brief reference to a few of them is made below.

Combustion and Magnetohydrodynamic Power

Research on combustion and power generation from combustion was the subject of a group of exhibits demonstrated by members of the Department of Fuel Technology and Chemical Engineering, Sheffield University. This department is working on an attempt to close the gap between the fundamental physics and chemistry of reactions and turbulence and convection flow, on the one hand, and practical burners, boilers and furnaces using atomised oil or pulverised fuel, on the other. Studies are also in progress on the use of an indirect arc furnace to obtain temperatures above 2000 deg. Cent. without an electric discharge and with any desired atmosphere in the furnace. Because the indirect arc used in the actual work has 5ft diameter mirrors and is too large for exhibition the exhibit was designed to show the principle of the system on a small scale. It illustrated concisely the work being done in the Department, both on the combustion of the single particles of coal and oil drops themselves by the shadow of the particle projected on to a screen, and on the flow pattern of the natural convection combustion gases around the particle as shown by the temperature differences in the gas around, which are made visible by the Schlieren technique.

In the whole programme this work on single particles is the first step from completely fundamental studies. Further steps are the controlled mixing history one-dimensional flame, in which every particle has identical combustion conditions, and the mixing of secondary air and recirculated combustion gases can be controlled in the experiment. The next step is semi-full-size flames, but under the complete control of the laboratory worker, such as are being carried out at Ijmuiden. The main point of interest in the single particle work is that the actual coal particles or drops of oil are very much more complicated in themselves than the simple systems, such as pure graphite or pure benzene, which are studied in the more completely fundamental physical chemical studies. The work on single particles of pulverised coal is part of a general programme sponsored by the C.E.G.B. in the Department at Sheffield University.

Another exhibit by this department presented an analogue of a magnetohydrodynamic generator of electricity by combustion gases. The basic idea of this proposal for generating electricity is that the combustion gases burn and reach a high temperature at a fairly high pressure, then expand through a nozzle to a very high velocity, and pass through a powerful magnetic field. If the gases are sufficiently good electrical conductors, electrodes at the sides can collect a current ; the power which is available in an external circuit comes from the slowing down of the hot gases, the direct kinetic energy being converted into electrical power with prospective gains in efficiency over the present-day combustion-steam-generation cycle. About seven years' work has been done at Sheffield on magnetohydronamic generation systems and, more recently, a number of organisations in the U.S.A. have done pilot plant experiments (for example, see THE ENGINEER July 15, 1960, page 123). The main problem is that the adiabatic expansion of the gases to high velocity causes a temperature drop, and it is difficult to have the sufficiently high electrical conductivity after this temperature drop, unless the gases are preheated to a very high temperature before combustion. Some proposals for overcoming this difficulty have been put forward at Sheffield, including the stratification of the gases into electrically conducting high-temperature layers, and thermodynamic working fluid, and the use of pulsating combustion, and the propagation of shock waves backwards and forwards down a tube with a magnetic field in the centre.

In the model shown at the conversazione mercury was pumped round a closed circuit and accelerated to a comparatively high velocity by a converging nozzle before being made to traverse a magnetic field. This model demonstrated the principle of producing a constant voltage difference across the fluid stream by increasing the length of the current path as the fluid is slowed down.

Graphite Technology

Graphite science and technology were illustrated in a group of exhibits contributed by Professor A. R. Ubbelohde, F.R.S. (Department of Chemical Engineering and Chemical Technology, Imperial College) London), and C. A. Parsons and Co., Ltd., and Hawker-Siddeley Nuclear Power Company, Ltd. The technological exhibits included one showing the great reduction in porosity that results from impregnation of graphite (Hawker-Siddeley).

Some interesting future possibilities were foreshadowed in a group of exhibits demonstrating the properties of pyrolytic graphite which is crystographically well oriented and is produced by heating graphite up to about 2000 deg. Cent. in a hydrocarbon atmosphere. Tubes and plates of such pyrolytic graphite were shown to be very stable at high temperatures and to be comparable with copper as conductors (in the α axis of the crystals) of heat and electricity. An application of these properties was shown in the form of a graphite/graphite thermocouple.

Electrolytic Machining and Deposition

An electrolytic machining apparatus and an electrolytic process for producing a thin-walled copper sphere were demonstrated

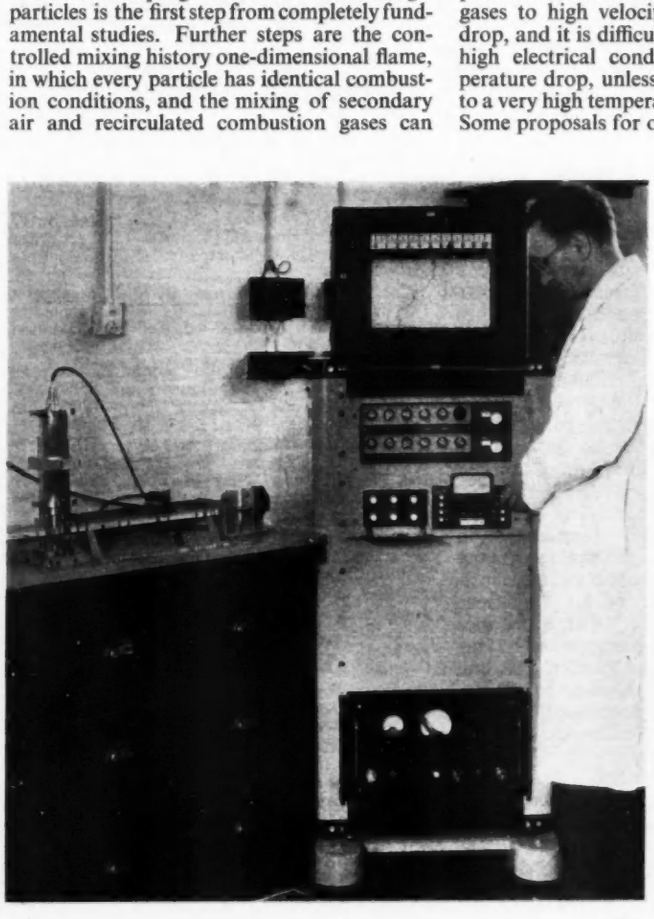
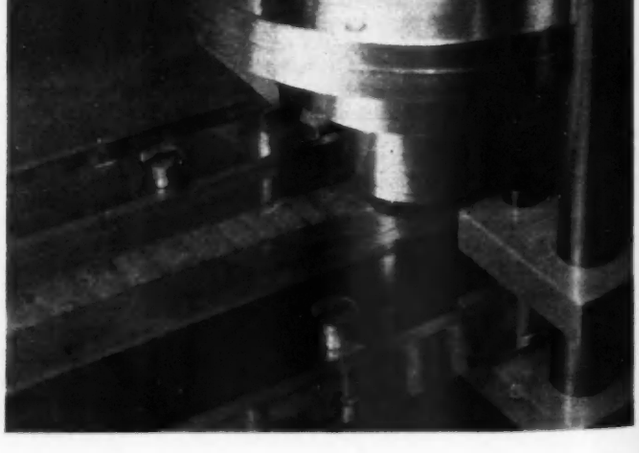


Fig. 1 (Left)—This instrument uses radioactive isotopes to make automatic measurements of the density of samples of wood—a first step in the improvement of timber quality by selective breeding

Fig. 2 (Below)— Specimens of wood mounted on plastic base "2," for automatic measurement of density by transmission of beta particles from radioactive carbon-14



by Professor J. S. Baker, F.R.S., Department of Engineering, University of Cambridge. The electrolytic machining apparatus has been developed for reducing the thickness, accurately and uniformly to any desired extent, of a flat metal specimen. In the other exhibit a thin-walled copper sphere of very uniform wall thickness is produced by electro-deposition of copper on a wax sphere which is rotated in an electrolytic bath. Subsequently, the wax former is removed by drilling a small hole in the copper and applying heat. Spheres made in this way are used in studying the stability of thin spherical shells subjected to uniform external pressure.

Very Thin Nickel-Iron Films

Some work on the electrolytic production of very thin nickel-iron films and their uses in very fast memory and counting devices was shown by Dr. E. Franklin and Dr. J. Stephen, Electronics Division, A.E.R.E., Harwell. Deposition techniques were demonstrated with an electrolytic cell, substrate materials and diagrams, with special reference to the deposition of minute quantities of cobalt–57 and iron–57 for sources and absorbers using the Mössbauer effect.

Plane and cylindrical nickel-iron films were shown in conjunction with their appropriate hysteresis loops and switching waveforms. There was also a magnetic scaler incorporating cylindrical films. It is a scale-of-ten instrument with a very low power consumption and a resolution time of 0·75 microseconds.

Damping Vortex-Excited Oscillations of Cylindrical Structures

A simple aerodynamic device for the suppression of vortex-excited oscillations of cylindrical structures was demonstrated by Messrs. C. Scruton and D. E. Walshe of the National Physical Laboratory, Teddington. Long tubular structures, such as chimney stacks and pipelines, tend to oscillate in winds because of the excitation set up by the cyclic formation and shedding of vortices alternately from either side of the cylinder in the airstream. This kind of periodic vortex discharge gives rise to alternating aerodynamic forces on the structure in a cross wind direction and resonant oscillation may ensue unless the damping of the structure is sufficiently high. However, the present-day trends towards refinement in structural design is usually accompanied by a reduction in the inherent damping and other methods of preventing oscillation of the structure have been studied.

One remedy, the principles of which were demonstrated in a working model at the conversazione, is to apply helical strakes to the surface of the stack. A convenient system found by experiment is a "three-start" helix of pitch equal to three times the cylinder diameter. The projection of the strake from the surface must be enough to prevent the regular formation of large scale vortices ; usually the projection height is about 0·09 times the cylinder diameter. This solution has been applied to some chimney stacks and transmission line towers and is to be used on a long pipeline suspension bridge which will cross the Brahmaputra River in India.

Automatic Measurement of Density of Timber Specimens

Apparatus for the rapid and accurate measurement of the density of timber specimens (as a criterion of timber quality) was shown by the Forest Products Research Laboratory and the Radioisotope applications Unit of the D.S.I.R.

Density is probably the best measure of timber quality, taking into account variations within the individual growth rings as well as the overall density of the wood. The apparatus developed specially for this work is fully automatic, microscale measurements of density being made by measuring the transmission of beta particles (electrons) through prepared thin specimens of wood. The specimens are cut by a special type of auger ; a microtone is then used to cut sections 100 microns thick and they are mounted on a plastics slide.

Briefly the apparatus (Figs. 1 and 2) consists of a radioactive isotope (Carbon-14) as the source of beta particles, an anthracene crystal, a photomultiplier and an electronic counter. As the plastics strip (marked "2" in Fig. 2) is passed between the radioisotope and the photomultiplier above it, the beta particles transmitted through the specimens of wood produce a flash of light from the anthracene crystal. The flash of light, directed on the cathode of the photomultiplier, releases electrons, which, at the next stage of the photomultiplier, release more, until an appreciable pulse is built up. An electronic amplifier further magnifies the output pulses, whose rate is then registered on a counter. The variation of density in the specimen as it moves automatically through the beam can thus be recorded on a graph, and when the operation has been completed, the instrument is automatically switched-off.

As a first step towards the selective breeding in timber cultivation, specimens of wood taken from trees grown in various parts of Great Britain are being examined by this method at the Forest Products Research Laboratory. The Forestry Commission has started its survey by taking samples from 180 Sikta spruce trees.

Image Splitting Microscope for Precise Measurements

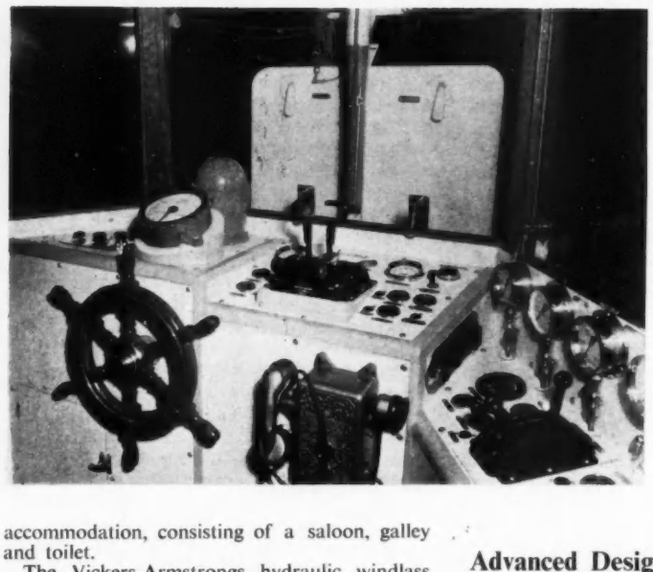
The accurate measurement of small objects under a microscope in conjunction with a moving wire micrometer is difficult because of limitations in the precision of setting and in the rigidity of the instrument. Greater precision is inherent in an image-splitting microscope which was demonstrated by Dr. J. Dyson of Associated Electrical Industries Research Laboratories, Aldermaston Court, Aldermaston, Berks. This instrument uses a principle known in astronomy for 200 years, whereby two identical images are formed and can be moved relatively to each other. A micrometer drive is used to set the two images edge-to-edge ; the images are then crossed over and the other edge-to-edge setting is made. The difference between the two micrometer settings gives the diameter. The accuracy attainable by this method is stated to be about ten times better than that suggested by the resolution of the microscope itself.

A commercial version of the instrument demonstrated is under development by an optical manufacturer.

Fireboat for Thames Service

A RECENT addition to the fire-fighting ships in the service of the London Fire Brigade is the "Firebrace," illustrated herewith, which has been designed specially to meet the needs of fire fighting on a tidal river. These call for a combination of a boat of high speed and shallow draught, and able to carry powerful pumps. "Firebrace" has been designed and built by Saro (Anglesey), Ltd., and is an all-welded steel vessel of round bilge form, having an overall length of 69ft by 13ft 9in maximum breadth, a maximum draught of 3ft 9in and an air draught of 11·9ft. The maximum speed is 11·5 knots. The hull is subdivided into five compartments, consisting of chain locker, hose room, engine and pump room, accommodation and aft peak. The deck is stepped down at the stern to within 3ft of the waterline and the boat's sides have a tumble home above a rubber fender which encircles the stern and extends forward over about three-quarters of the length of the vessel. A non-slip composition is laid over the deck, in which are portable panels to give access to the machinery spaces for repair purposes. Watertight hatches give access to the hose room, which is fitted with timber racks and steel shelves, to the machinery space, and to the aft peak housing the Chadburn steering gear operating the twin spade rudders. A companionway leads down from the aft platform to the

Fireboat "Firebrace"



View of wheelhouse showing console mounting with main engine and pumping machinery controls

accommodation, consisting of a saloon, galley and toilet.

The Vickers-Armstrongs hydraulic windlass suitable for handling $\frac{9}{16}$in stud link cable is mounted forward, and aft is a hydraulic capstan near which two additional anchors are stowed. Deck fittings include a shore electrical supply box, a telescopic mast, roller fairleads, and beam bollards, a 5in pedestal-mounted Merryweather monitor, a four-way delivery head to port and starboard, and four 6in swivelling suction heads for salvage services. In the wheelhouse, of which we reproduce a general view, are the propulsion engine "Bloctube" controls, navigation instruments and radio, pumping engine controls, &c., while on top is mounted a searchlight. Abaft the wheelhouse is a light hose reel and sockets to take two floodlights and two 500W cargo clusters.

In the machinery space are the propulsion engines and pumping units, and the former consists of two Dorman 6 Q.A.M. diesels, each developing 228 b.h.p. at 1800 r.p.m., and driving through a self-change gearbox, giving a 2 to 1 reduction ratio, with oil-operated clutches for ahead and astern engagement. Each engine also powers a hydraulic pump to supply the windlass and capstan. The propeller shafts are of stainless steel and run in water-lubricated rubber bearings. At the forward end of the space is a 20kW Stamford alternator powered by a Russell Newbery D.D.U diesel engine which is clutch coupled to a Merryweather hose reel pump of 25 gallons per minute capacity at 120 lb per square inch. A rectifier unit of 3kW capacity is available to convert 240V a.c. to d.c. for floodlighting. For supplying water for fire-fighting there are two two-stage Merryweather 6in pumps, each driven by a 6 Q.A. Dorman diesel engine having a continuous rating of 213 b.h.p. at 1800 r.p.m. The duties of which the pumps are capable range from 2160 gallons per minute at 80 lb per square inch, to 1150 gallons per minute at 170 lb per square inch. The pumps, which are constructed of gunmetal and have bronze spindles and impellers, draw independently from a copper main, which cross connects the water inlet strainer boxes at the sides of the hull and is branched to the deck suction points, and supply the monitor or delivery heads either independently, in series or in parallel.

All five diesel engines are electrically started by push buttons in the wheelhouse from a 24V, 190 Ah. Nife battery; however, in addition, Bryce Berger starters have been provided for the four main engines. A general purpose 24V, 200 Ah. Nife battery is installed for emergency lighting, &c., and the equipment includes a battery charger. Exhaust gases from the four "Dorman" engines are water injected and led through a rubber hose to the stern. A total of 3·4 tons of fuel is carried in tanks integrally constructed with the hull to port and starboard at the aft end of the engine-room and under the floor between the engines. Ventilation supply to the machinery space is effected by four water excluding vents, and the skylight, while extraction of air is by two 5in Blackman fans.

Advanced Design Shopping Centre for Birmingham

WORK has started on the construction of the Bull Ring Centre, Birmingham, which is to cost £5,000,000, and is claimed to be the most advanced shopping area in Europe. Design and development of the centre are the responsibility of the Laing Development Company, Ltd., and its construction is being undertaken by John Laing Construction, Ltd. The centre is being built in the traditional market and trading area of Birmingham, and will occupy a site of some 4 acres, divided by the new inner ring road into three sections. These will be linked by covered bridges which will themselves form part of the shopping area. Within the centre there will be 350,000 square feet of retail shopping space in 140 shops, department stores, supermarkets, a general retail market covering 36,000 square feet and a separate fish market of 14,000 square feet. There will also be restaurants and coffee bars, licensed premises, banks, a baby crèche and perambulator park, a multi-storey car park, a central bus station and a seven-storey office block. Facilities for recreation and entertainment, including banqueting rooms with accommodation for 2000 people, will be included.

All the trading accommodation will be contained within the main structure of the centre, and in all public areas the temperature will be controlled throughout the year from a central-heating and air conditioning plant. Each individual shop will have its own control over the air conditioning. Construction will be mainly in reinforced concrete of normal type, but one of the two bridges, which crosses the twin roadway part of the inner ring road will have its 140ft span of steel. The site slopes fairly steeply in a south-westerly direction and advantage has been taken of this fact to plan vehicle access from street level. Cars entering the multi-storey car park, for example, will do so through a 40ft-wide entrance from the inner ring road and will approach the parking area over the top of the first shopping floor. Exit from the car park will be into the same road, through an archway similar to that provided for entry.

From a design and planning point of view the principal point of interest in the project is the provision which has been made for traffic flow, both pedestrian and vehicular. It is estimated that about 40,000 people can be in the building at any one time without overcrowding, and there will be ample stairways, courtyards and circulating areas as well as wide corridors between the shops. Fifteen entry points will be available for pedestrians, who can enter from several streets, from a central bus station beneath the building or by covered way from New Street station of British Railways. This station is to be rebuilt, and will provide both suburban and long distance transport services. The bus station will be used by the Birmingham and Midland Motor Omnibus Company Ltd., whose services extend over a very wide area in the Midlands; it will be capable of handling some 18,000,000 passengers a year. As the accommodation is on several floors, twenty-nine escalators—up and down—will be installed to speed-up pedestrian movement.

For vehicular traffic there are three groups of entrances and exits in the scheme. Midland "Red" buses will enter and leave the underground bus station by private roads. Cars, as already mentioned, will have a separate entry and exit from the ring road, and a marshalling area inside the building will make it possible for a car to drive straight in from the public road and, if it is necessary to wait a short time before going to the car park lift, the waiting will be done inside the centre; there will be no congestion on the road outside. Similar arrangements are planned for commercial vehicles serving the shops, stores and markets. Provision will be made for simultaneous loading or unloading of up to fifty lorries, which will have a separate entrance and exit and a waiting area. Enquiry desks will be provided in this area, and lorry drivers will be directed from this point to the loading or unloading deck. To obviate interference with pedestrians in the shopping area there will be separate goods lifts and service corridors giving private access to every part of the trading area.

Architect's drawing of Bull Ring Centre, Birmingham

SHORTER REPORTS

St. Lawrence Seaway

THE St. Lawrence Seaway Authority has presented its annual report for 1960 to the Canadian House of Commons. The report relates to the first full year of administration of the Seaway (although it is the second year of full navigational use), and records a decrease of 1·4 per cent in the traffic using the Montreal–Lake Ontario section, and an increase of 8·7 per cent in the Welland Canal, over the 1959 traffic. This disappointing result has led to a loss by the Authority of about 9,500,000 dollars for the year.

Work continued throughout 1960 in completing a number of contracts and in improving some facilities, particularly on the Welland Canal, such as a programme of fendering at lock approach walls. Vessel handling and traffic flow in 1960 improved over the 1959 season, the Authority reports. On the Welland Canal, the new tie-up walls above and below the locks resulted in a smoother flow of vessels and reduced transit time, and unlike 1959, there was very little congestion caused by vessels awaiting entry to the canal.

The Authority's income in 1960 amounted to 9,360,642 dollars. The net administration and operating cost was 5,908,943 dollars, and the income available for "debt service" was therefore 3,451,699 dollars, which has been paid to the Government on account of interest on capital debt. The full interest charge was 12,791,197 dollars. After recording a charge for 92,190 dollars for replacement of movable capital assets, a net loss of 9,431,688 dollars for the year is shown.

It is stated that the income from the tolls for the Welland Canal Section of the Seaway was inadequate to meet the costs of its operation. The Authority was indebted to the Government of Canada to a total of 339,927,117 dollars at March 30, 1961. In the light of the above, the Authority states that it is re-appraising its financial structure and is re-examining its financial position with respect to the Welland Canal.

Power "Black-Out"

IT is reported that the Central Electricity Generating Board has set up a committee of inquiry to investigate the electricity supply failure which affected large areas of south-eastern England, including parts of London, on Monday evening, May 15. While it would be pointless to prejudge the issue, the extensive nature of the failure suggests that the initial fault was followed by a series of tripping operations caused by overloading or power surges on the circuits involved.

Electronics in Airways Traffic Handling

Two applications of electronics to passenger booking and aircraft loading procedures are the subject of announcements by Standard Telephones and Cables, Ltd., Crown House, Aldwych, London, W.C.2. They relate to an order received by the company from the British Overseas Airways Corporation for an electronic system to facilitate passenger seat reservations through ticket selling offices ; and to a computer installation now in use by the Scandinavian Airlines System at Kastrup Airport, Copenhagen, for aircraft load control and passenger check-in.

The B.O.A.C. system will comprise, initially, a central magnetic drum store of flight information in Airways Terminal, Buckingham Palace Road, London, serving about 100 sales personnel using special keying sets within the Terminal Building itself. It is planned that this installation will be ready for service in the latter part of this year. Later, the system will be extended, using telegraph circuits, to various points in London including London Airport. Further geographical extensions will be made over standard telegraph channels.

Each sales clerk within the system has access to a push-button unit for interrogating the computer store at Airways Terminal. The drums to be used have 1000 bit positions on

Fig. 1—Control clerk's desk unit for feeding aircraft seat availability information into a central store

320 tracks. Flight status records are written along drum lines, each of which consists of a number of track positions along a common angular position. Each sales clerk has a set of "flight plates" which are thin metal plates with standard flight information printed on both sides. These are supplied periodically from the control centre at Airways Terminal and show the pattern of flight information for twenty weeks ahead. When the clerk receives an inquiry he selects the appropriate plate, which contains details of related flights, and inserts this into the desk unit. Notches in the plate operate microswitches in the unit and identify the plates and the side which is being studied. He then presses buttons on his desk unit corresponding to the departure and arrival points on the sector of the route in question. He also presses buttons corresponding to the relevant date and class.

Having thus set up the interrogation formula, the clerk presses his "set" button, which causes the pattern of closed and open contacts set up by the push buttons to be scanned electronically and converted within the unit into code impulses which are transmitted direct to the central processing equipment. Replies from the information store are displayed as a pattern of lamps on the clerk's unit. This information is also transmitted in high-speed code impulses, but instead of passing direct to the interrogating desk unit, these impulses operate relays which act as a store, the desk unit display remaining illuminated until the lamps are extinguished by a "release" button. When ten flights operate to a common destination on a day interrogated, the seat availability situation on these ten flights will be presented simultaneously.

The control clerk's key set (illustrated) is similar to that of the sales clerk but has additional buttons for feeding information to the magnetic drum store. By pressing an "act" button, the control clerk cancels the existing information in the drum store and "writes-in" the new status information so that sales clerk's interrogations will always yield the correct answers. The system permits the control clerk to revise flight status in approximately one second and from this moment the revised information is available for any subsequent interrogation throughout the network.

The second illustration shows the apparatus supplied to Kastrup for aircraft load control. This system collects passenger check-in data from all reception counters, computes and totals these data to provide the information needed for the compilation of aircraft load sheets and prints out load sheets, load messages, &c., for each destination of every flight departing from Kastrup. The equipment comprises a "Stantec Zebra" computer connected to push-button input sets at the check-in counters, and master sets (for input and output) at the load control. Input consists of basic aircraft data, and the output (either on a visual display or a printer) of load status and seat status reports together with load sheets and load messages for transmission to each destination of the flight concerned.

[Reply Card No. E8233]

Fig. 2—Computer and input/output devices for aircraft loading calculations at Kastrup Airport, Copenhagen

SHORTER REPORTS *(continued)*

American Computers to be Marketed in Europe

An electronic data processing division has been set up by Honeywell Controls, Ltd., Greenford, Middlesex, to market two American computers—the Honeywell "800" and the Honeywell "400"—in this country and on the Continent. The "800" computer is described as a medium- to large-scale system suitable for commercial, industrial, and scientific work. The "400" is a small-to-medium magnetic-tape system suitable for smaller organisations particularly those that are growing rapidly. Both models of computer are fully compatible with each other. Comprehensive services will be available, including an electronic data processing service bureau which is to be established soon in London.

The Honeywell "800" is designed for automatic parallel processing and can perform up to eight independent computing operations concurrently. For example it can, simultaneously, answer a random enquiry, bring an inventory up to date, process a payroll, complete a complex mathematical calculation and make a special analysis, with enough capacity in reserve to carry out three other jobs at the same time. Two innovations, known as "traffic control" and "multi-programme control," are involved in automatic parallel processing. Traffic control enables the central processing equipment to communicate simultaneously with peripheral devices over sixteen channels and removes the limitations resulting from the relatively slow speeds of this peripheral equipment. Multi-programme control enables the simultaneous inputs and outputs associated with traffic control to be under the control of several independent programmes.

Thus if one programme requires 10,000 instructions per second, additional programmes (e.g. one at 700 per second and another at 3000 per second) can be run simultaneously, giving a 66 per cent machine "efficiency" against a maximum of 30,000 instructions per second.

The magnetic tapes operate at a maximum of 96,000 decimal digits per second; when communicating with the maximum combination of tapes this achieves a reading and writing rate of 1,536,000 decimal digits per second. The internal transfer rate is 2,000,000 decimal digits per second. The average order speed is 30,000 three-address orders per second (equivalent to 60,000 single address orders per second).

The "800" machine embodies a system known as "orthotronic control" for the automatic detection and correction of errors whereby lost or garbled data are automatically reconstructed.

Because of its modular design the computer can be tailored to meet specific needs by adding modules as required. A typical system would cost about £395,000 (or monthly rental of £8500), with delivery in twelve to fifteen months.

The Honeywell "400" is a junior version of the "800" computer and is claimed to give tape and card processing at the cost of a card system. It can handle an average of 10,000 three-address operations per second. The basic equipment costing £139,000 (or monthly rental £3090) includes the central processing equipment, an independent console, four high-speed magnetic tape units (96,000 decimal digits per second), a printer (900 letters per minute) and a card reader (650 cards per minute).

Automatic programming systems are available to increase the speed and reduce the cost of preparing problems for the computers. For the "800" machine there is a data processing compiler known as FACT (Fully Automatic Compiling Technique) which eliminates manual programme coding by enabling the computer itself to translate simple statements in business English into computer language. Other programming aids for the "800" are an algebraic compiler, and an assembly programme known as "Argus."

The automatic programming system (known as "Easy") for the "400" computer is an integrated system supplemented by "sort" and "collate" generators, an automatic check-out system, and routines for programme tape file maintenance and library maintenance.

[Reply Card No. E8241]

New Passenger Car

The place of the "Prefect" in the range of products of the Ford Motor Company, Ltd., is to be taken by a car called the "Consul Classic 315"; it is the first English Ford model to be offered with an option of two or four doors since before the war. As will be apparent from our illustration, the new car resembles in appearance the "Falcon" compact and the Taunus, differing from the latter essentially in having been developed to meet colonial conditions, but mechanically it is closely related to the "Anglia" 105E. The 80·96mm bore engine has been enlarged to have a stroke of 65·07mm, raising the capacity from 997 c.c. to 1340 c.c., but the four-speed gearbox is retained; a steering column remote control is nevertheless available. Another contrast to all other "Consul" cars is that the "Classic" conforms to English standards of safety by combining a semi-floating live axle with a brake system that is ineffective in the absence of one rear drum.

The new car has a wheel-base of 99in and a track of 49½in; it will be recalled that these measurements were in the ratio of 2 : 1 on the original "Anglia." The turning circle has a diameter of 34ft. It has the MacPherson front suspension familiar on European Ford products, while at the front disc brakes are standard, instead of optional as on the "Three Graces."

A distinctive feature of the body is that the rear window is raked in the opposite direction to normal; this styling has the consequence that only the front part of the windows in the rear doors of the four door model can wind into the doors, and the rear part, like the quarter light on the two door version, pivots outward about the leading edge. Another unusual detail is that the bonnet, also pivoted at the front, is secured by catches at both sides.

Unconventional design is also evident in the electrical system. There are three light switches: a main switch on the instrument board turns the lights on and off, varies the instrument lighting and, at full brightness, brings on the cabin lighting; the direction indicator switch flashes the headlamps (on de luxe models); and there is a foot-operated dipswitch. An electric screen wiper is fitted, but its speed is variable and it is controlled by a knob moving in the natural sense, rotation in the transverse plane; on the de luxe version pressing this knob works the windscreen washer. The twin horns on the de luxe model are operated by a horn ring under the steering wheel.

Other distinguishing features are that, on the de luxe, the interior door opening handles are incorporated in the padded arm rest/door pulls, as on a Taunus. Interestingly, the handbrake is controlled by a simple pistol grip devoid of the turn-to-free feature of the current "Consul." A heater/demister is an optional extra; it is designed to offer stratified ventilation in which the bulk of the air delivered is heated but cool demisting air surrounds the occupants' heads—this is expected to reduce the risk of the driver becoming drowsy.

The car is claimed to cruise very close to the top speed (fully laden) of approximately 80 m.p.h. From rest to 60 m.p.h. takes twenty-three seconds, and in top gear acceleration from 30 to 50 m.p.h. is quoted as thirteen seconds. The fuel capacity of 9 gallons is expected to give a range of 300 miles.

Analysis of the "Consul Classic 315" in the Ford anechoic laboratory with sound absorbing floor, walls and roof. Any kind of "road," load, speed and gradient can be simulated in this facility at Dearborn

Leading Particulars

Engine output :	
Gross power	56·5 h.p. at 5000 r.p.m.
Net power	54 h.p. at 4900 r.p.m.
Peak brake mean effective pressure	138·5 lb per square inch at 2500 r.p.m.
Compression ratio	8·5 : 1 (7·5 : 1 optional)
Gearbox :	
Fourth	1 : 1 (synchromesh)
Third	1·412 (synchromesh)
Second	2·396 (synchromesh)
First	4·118
Final drive	4·125
Brakes :	
Front	9½in disc
Rear	9in by 1½in drum
Tyres	5·60×13 4 P.R. tubeless
Exterior dimensions :	
Overall length	14ft 2¾in
Overall width	5ft 3½in
Overall height	4ft 6½in
Ground clearance	6½in
Kerb weight :	
Two-door	2025 lb
Four door	2080 lb

Automatic Car Park

A MULTI-STOREY car park, which depends on a fully automatic, mechanical system for moving cars in and out of the parking building, has been completed at Beresford Street, Woolwich, S.E., and was opened on May 11 by H.R.H. Princess Margaret. The building has eight parking floors above a showroom, and it accommodates 256 cars. It is known as an "Autostacker," the licensees for the mechanical system which it utilises being Auto-Stackers, Ltd. (a firm associated with John Brown and Co., Ltd., and Standard Telephones and Cables, Ltd.), and it was built by Truscon, Ltd.

The building has four lifts, so each lift commands sixty-four vehicle spaces. The building can be considered as divided into three rows longitudinally, the two outer rows being parking spaces. The lifts are placed in the central row, at the ends and middle, and each one carries a "transporter," which, at any floor, can be traversed along the central row (it runs on steel rails) and placed opposite any given parking space.

When a car is to be parked, it is driven on to one of the eight loading conveyors placed on either side of the lifts at ground level. The parking operation is initiated by the attendant in the control kiosk and the car is moved forward on to the transporter standing on the lift. The transporter also has twin conveyors on which the car stands. The lift rises to the selected floor; the transporter traverses along the central gallery to the chosen parking space. And then the conveyors on the transporter propel the car into the space, whereupon the conveyors in that space complete the parking operation. The rear wheels of the car are always nearest the gallery. The transporter may then return to ground level or proceed to collect another car.

Operation is by electrical signals transmitted from a central control unit which is essentially a series of relays and sequence interlocks which ensure that each succeeding operation will take place only after preceding events have correctly occurred. The principle of operation is quite straightforward, depending on recognised electrical and mechanical practices.

The maximum and minimum times taken to complete an operating cycle are respectively seventy-five and twenty-three seconds, and the entire capacity of 256 cars can be discharged in about fifty-five minutes.

The transporter consists of a frame mounted on two powered and two trailing wheels which run on 2in by 2in square rails set on the concrete longitudinal gallery beams. A two-speed electric motor drives it through a bevel gearbox. The transporter conveyors and interposing rollers are driven by an electric motor which, through a thrustor-operated dog-clutch, also powers the conveyors in the parking space which is being occupied or vacated.

Locating switches on the transporter secure exact alignment with the car space. Similar switches are used for aligning the lift at each floor level.

The conveyors in the car space, which complete the parking operation, are of sufficient length (about 6ft) to ensure that no part of the car protrudes into the gallery after the car has come to rest.

The conveyors, which are pressed steel pan conveyors, are in pairs, one 7in wide which is sufficient for the largest tyre, and one 1ft 8in wide to accommodate the varying track widths of vehicles. There is a continuous kerb 4in high each side of the smaller conveyor and on the outside of the larger conveyor, to prevent the car from straying.

The loading conveyors on the ground floor are self-powered; they are 18ft long and fitted with a series of photo-electric cells connected to the control light that shows the motorist when he is correctly parked. These loading conveyors each have a sensitive edge gauge which will reject an oversize or unsuitable vehicle. Similarly, the sensitive edge on the lift gates will reject a vehicle that is too long or has a longitudinal projection.

The lift is of a cantilever design, allowing acceptance or discharge of vehicles on three sides. It carries the transporter on a pair of rails which match with those at each floor. Its winding machinery is at the top of the structure in a weather-proof house which also contains all the electrical contactor gear. The winding unit is counterbalanced, sheave driven, and powered by a two-speed electric motor through a worm gear reduction which carries duplicate electro-magnetic brakes. The cage is suspended by multiple lifting ropes, as is the counterweight which passes down the back of the lift between its main members. Accurate positioning of the lift at the selected floor is ensured by reducing speed at approach and by levelling switches. An auxiliary levelling motor is brought into operation to compensate the change of rope stretch as the transporter moves on or off the lift.

Successive operating cycles are regulated by a sequence interlock of the programme control. Single pulse, 50V, milliampere control signals are initiated from information received in the control units on the ground floor, and conveyed to the motor controls via a battery of relays in the lift motor room. At this point in the circuit, the automatic control may be switched out and manual control substituted, e.g. for maintenance. No control or switch wiring for the parking spaces is required in the structure of the building. All power and control is carried by a multicore cable from the motor room to the lift and thence to the transporter via a reeling drum.

[Reply Card No. E8251]

The Bonallack "Pneumarator" discharging an 8-ton load of feeding stuff directly into a silo

Pneumatic Discharge Vehicle

THE latest addition to the range of pneumatic discharge vehicles, the "Pneumarotor," manufactured by Bonallack and Sons, Ltd., of Nevendon Works, Basildon, Essex, has been specially designed for the bulk transport of animal feeding stuffs and grains. The load-carrying compartment of the vehicle is constructed of aluminium alloy sheet and extruded sections, and the flooring is made up of the company's interlocking extruded alloy decking "Dekaloy," which is mounted on a mild steel tipping subframe. Two versions of this vehicle are available, both of them in several sizes. One version has fully interchangeable drop sides and a removable tailgate allowing the vehicle to be converted into a flat platform truck, whilst the other version has fixed sides. Both versions can be supplied with either a canvas cover sheet or a removable aluminium alloy roof. The "Pneumarotor" shown in the illustration we reproduce has a capacity of 540 cubic feet and is mounted on a 7-ton, 13ft 6in w.b. Commer chassis, but the unit may be mounted on any suitable tipping chassis.

Two removable partitions, which are hinged at the top, allow the interior of the vehicle to be separated into three compartments of equal capacity. The partitions are locked in the vertical positions by shoot bolts operated from outside, and when released, swing to the angle of tip, thus bringing the load to the rear of the vehicle.

The pneumatic discharge equipment comprises a sunken hopper across the full width of the floor at the rear of the vehicle, fitted with calibrated sliding traps for controlling the input of the load into a rotary-feeder valve, which also extends the full width of the body. The rotary feeder valve, which was also designed by the builder, is driven hydraulically by the pump which operates the vehicle's tipping gear. A positive displacement compressor, driven by a power take-off from the vehicle's engine gearbox, supplies 285 cubic feet of free air per minute, the maximum working pressure being about 10 lb per square inch.

When material is being discharged from the vehicle pneumatically, tipping is only necessary in the final stages in order to shift the residue of the load from the forward end of the compartment to the hopper at the rear.

The tipping gear may be used independently when gravity tipping is required instead of pneumatic discharge.

Rates of discharge are dependent upon the type of material being handled and the height or distance to which it is being delivered.

[Reply Card No. E8252]

Short Range Jet Airliner

A JET airliner with direct operating costs similar to those of the Vickers "Viscount" has been projected and is being built by the British Aircraft Corporation. The new BAC-111 will be ready for service, it is anticipated, in late 1964, about one year earlier than the rather smaller BAC-107. Like the earlier design, it will have twin engines mounted in pods on the after fuselage; they will be Rolls-Royce "Spey" RB 163-1 with a by-pass ratio of unity, guaranteed to give 9860 lb s.l.s. thrust and expected to have a consumption of 0·776 hour^{-1} at M. 0·78 at 25,000ft I.S.A. (The BAC-107 will have Bristol Siddeley 75 ducted fans of 7350 lb thrust.)

The new aircraft is designed to cruise at up to 540 m.p.h. and to carry up to sixty-nine tourist class passengers. The formula costs appear to be lower than the formula costs of the "Viscount" for stages longer than 200 miles. (No corroboration of the formula costs for the older machine has been submitted.)

Length overall	93ft 8in
Wing span	88ft 6in
Wing area	980 square feet
Aspect ratio	8
Wing sweep on quarter chord	20 deg.
Tyre pressure at maximum weight	120 lb per square inch
L.C.N. at maximum weight	32
Total accommodation length, including toilets and galleys	53ft 9in
Interior width at arm-rest height	10ft 4·3in
Capacities:	
Fuel (8 lb per Imp. gall)	18,000 lb
Freight volume	500 cubic feet
Weights:	
Maximum ramp weight	66,300 lb
Maximum take-off weight	66,000 lb
Maximum landing weight	62,500 lb
Maximum zero-fuel weight	56,000 lb
Design maximum payload	14,000 lb

Ten machines have been ordered, with an option on five more, by British United Airways.

SHORTER REPORTS *(Continued)*

2 cubic yard capacity, four-wheel drive, tractor shovel

Tractor Shovel

A FOUR-WHEEL drive tractor shovel of 2 cubic yards or 12,000 lb lifting capacity, which was recently introduced by the Yale and Town Manufacturing Company, Wednesfield, Staffs., is illustrated on this page. The "Trojan" tractor shovel is a development of an earlier 1½ cubic yard machine and is driven by a Leyland diesel engine developing 105 h.p. at 2200 r.p.m. with a torque of 270ft/lb. It digs from 12in below ground level and the maximum tipping height to the lowered bucket lip is 8ft 10in. The cranked bucket arms are actuated by hydraulic cylinders and the bucket is raised to its full height in eight seconds. Two hydraulic rams used to tip the bucket enable a load to be dumped in under two seconds. Hydraulic power for shovel operation is provided by a gear pump delivering 42·7 g.p.m. at 2000 r.p.m.

Power is transmitted through an Allison "Torqmatic" torque converter transmission mounted integrally in the housing. The machine has three travelling speeds of 3, 8 and 21 m.p.h. in both directions of travel and a selector is provided to give either front-wheel or four-wheel drive. The tractor has a turning radius of 22ft and, if required, hydraulically assisted steering can be provided. Hydraulically-operated brakes supplemented by a vacuum boost are fitted on all wheels and a mechanical parking brake operates on the propeller shaft.

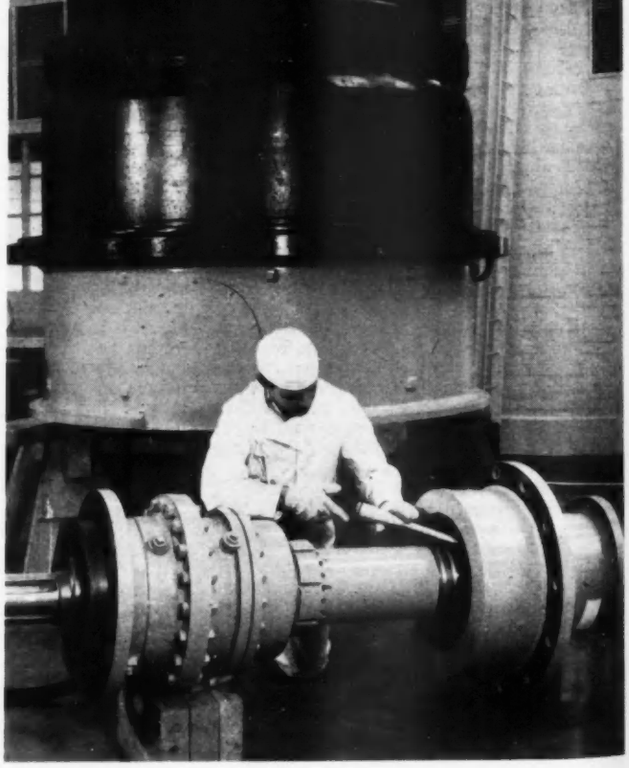
The attachments available for use on this tractor include a scarifier tooth assembly for which mounting brackets can be welded to the rear of the bucket. During normal shovel loading work these teeth are hinged back and locked. A 91in wide 29in high bulldozer blade can also be fitted in place of the bucket and interchange is effected by the removal of only four pins. These machines are distributed in this country by Jack Olding and Co., Ltd., of Hatfield, Herts.

[Reply Card No. E8261]

Assembling Gas Circulators for Hunterston Nuclear Power Station

COMPONENT parts of the CO_2 gas circulators for Hunterston power station are being manufactured, finally cleaned, and assembled at the Erith Engineering Works of The General Electric Company, Ltd. Our illustration shows an operator cleaning the thrust bearing carrying the hollow impeller shaft of one of these circulators. This operation is done under "nuclear clean" conditions, as is the subsequent assembly of the shaft inside the dome casing seen in the background. On top of this dome casing is the impeller, awaiting assembly on its shaft. After assembly and packing, this machine will be taken to the South of Scotland Electricity Board's site at Hunterston. In operation this gas circulator will handle 710 lb of carbon dioxide per second, and it will be driven by a 1230V, 2354 h.p., 1040 r.p.m. double-armature d.c. motor.

On the left-hand end of the impeller shaft can be seen the Crane gas seal assembly which has been specially developed to minimise leakage of the carbon dioxide coolant at the point where the shaft penetrates the pressure shell of the steam-raising unit. The seal will be supplied with oil which will be automatically maintained at a pressure 10 lb per square inch lower than that of the circulating carbon dioxide. In service the leakage of carbon dioxide through the seal will be less than 0·03 lb per hour, and this leakage will be directed to the seal oil tank which is fitted with a stack to allow the gas to escape.



Gas circulator for Hunterston nuclear power station. An operator is shown cleaning the thrust bearing carrying the hollow impeller shaft before assembly of the shaft inside the dome casing (background) at the maker's Erith works

A Preservative for Timber

A SOLUBLE sodium borate is now being used as a preservative for timber, under the trade name of "Timbor." The preservative is applied to the timber in solution, either by spray or in an immersion tank, when the timber is freshly sawn. The high water content of the unseasoned timber is thus made use of, to spread the preservative through the timber by diffusion, which proceeds until solution equilibrium is attained. Complete penetration of timbers up to 3in thick thus is claimed, and substantially complete penetration for most types and sizes of commonly-used timber. Subsequent seasoning of the wood imparts permanency to the impregnation, which is then resistant to leaching. Complete toxicity to wood fungi and to wood boring insects is achieved, it is claimed. However the use of "Timborised" timber, as it is called, is recommended only for timberwork protected by roof or paint, and not for timber buried in the ground or where there are severe leaching hazards.

The treated timber is to be sold from normal stock, and can be cut and worked, or stuck together or painted, as normally. Treatment of the "green" timber is carried out at the sawmills, which in this case are Finnish. Several merchants in this country will supply the treated timber, which has been shipped by the Finnish company Rauma-Repola Oy; the preservative is supplied by Borax Consolidated, Ltd., and other development work has been done by the timber constructors, Vic Hallam, Ltd., and F. and H. Sutcliffe, Ltd.

This form of treatment was initially developed in New Zealand and has been extensively used there, the British system having been developed from it. About ½ lb of preservative is used per cubic foot of timber, which increases the cost of the timber by perhaps 5 per cent but at any rate not more than 10 per cent.

[Reply Card No. E8263]

Abrasive Sponge Wheels

An abrasive sponge finishing wheel with a degree of flexibility and resilience which enables curved, flat and profiled surfaces to be dealt with in one operation is to be marketed by Finishing Aids and Tools, Ltd., Chandos House, Buckingham Gate, London, W.1. The resilient structure of the sponge enables close and continuous contact to be maintained with the workpiece and only light contact is necessary. When using these "Artifex" sponges, one of which we illustrate, no coolants lubricants or compositions

Abrasive sponge wheel for surface finishing

are required and only light and infrequent dressing is needed. The wheels can be worn down almost to their clamping plates and then used as small diameters on tapered threaded spindles.

The sponges are recommended for general surface treatment and produce matt or polished finishes on stainless or other steels, iron, brass, copper, bronze, aluminium, plastics and hard woods, while they are claimed to polish precious metals with a minimum of stock removal.

Sponges are available in four grades—soft, medium hard, hard, extra hard—and in a range of grain sizes as wheels up to 16in diameter and 4in thick. The maximum safe wheel speeds range from 2000 to 6000 surface feet per minute, according to grade.

[Reply Card No. E8271]

Horizontal Forging Machine for Large Tube Ends

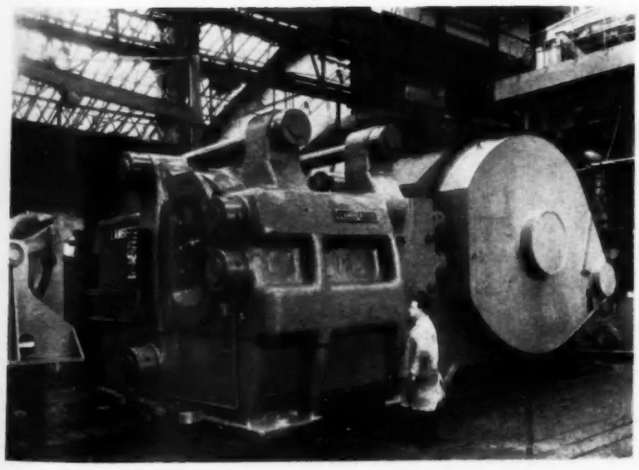
A horizontal forging machine capable of exerting a forging pressure of over 200 tons has been designed and built by Lamberton and Co., Ltd., of Coatbridge, and installed in the Mossend Tube Works of Stewarts and Lloyds, Ltd. This machine has been installed primarily for upsetting the ends of the steel tubes up to 10in diameter which are used for lining deep oil wells. The upset ends of the tubes are threaded, male one end and female the other end.

The new machine, illustrated on this page, weighs about 300 tons, and its main frame was made in two pieces, one weighing over 100 tons. Forging is carried out by a series of punches carried in the main slide driven directly from the crankshaft which is driven by a 250 h.p. motor through vee belts and reduction gearing. This main slide has a stroke of 30in and, as only single stroking is required, a multiplate clutch and disc brake are incorporated in the drive. The clutch and brake are operated by compressed air and in the event of failure of the electrical power supply the clutch is disengaged and the brake applied.

Production line for a motor trim component. This line incorporates a diecasting machine, clipping press band grinding and inspection stations and a multi-head drilling and tapping machine

Tubes are held for the forging operation by a side slide, carrying gripping dies, which is operated through toggles by cams from the main crankshaft. The tubes are delivered from an end heating equipment on to manipulator rollers on which a tube is raised to the level of the first die position and moved forwards into the dies when it is gripped ready for forging. After each of the successive forging operations carried out in the machine the manipulator lowers the tube into alignment with the next die. In our illustration the first arm and roller of the manipulator can be seen facing the machine to its left.

[Reply Card No. E8272]



Horizontal forging machine for upsetting the ends of large tubes

Pressure Diecasting Works

With the recent opening of extensions to the works of Hills Precision Die Castings, Ltd., at Hall Green, Birmingham, about 8000 square feet has been added to the productive floor area and a further stage in a programme of works reorganisation has been completed. This company was founded seventeen years ago for the manufacture of zinc base pressure diecastings for the motor car and other industries and more recently has engaged in the production of aluminium diecastings.

The main diecasting shop is equipped with fifteen machines, twelve of which produce castings in "Mazak III" and the other three castings in aluminium alloys. In this section extensive use is made of four- and two-unit die blocks in which each unit may carry any of a number of different individual die impressions. This system, in addition to reducing the time involved in tool changing, also helps materially in improving the economics of relatively short run requirements. Under a cast/clip arrangement which has been adopted a clipping press is situated conveniently near to each casting machine so that the operator can place the spray of castings removed from a casting machine directly into the press during the normal cycling time. The tooling of a clipping press can also be made up on a unit principle corresponding to that of the diecasting machine to avoid time loss in tool changing.

Clipped castings from the diecasting area are fed into a workbank adjacent to the casting shop area where they are stored in pallets. It is considered more convenient and economic to manufacture castings in reasonable production quantities and store them in this bank, from which they can be subsequently drawn for finishing operations to meet customers' scheduled requirements. Batches of castings withdrawn from this workbank to a customers' weekly requirements are fed through into successive finishing lines in the machine, polishing, plating, painting and assembly shops.

For certain classes of product the diecasting machine is linked up to a finishing line, as shown in our illustration. Here a motor car trim component, clipped on the press adjoining the diecasting machine, drops through the tool on to a belt conveyor. This conveyor carries each casting through a band grinding and an inspection station to a multi-head, indexing table machine where its five holes are drilled and tapped.

SHORTER REPORTS *(continued)*

Register-Translator Equipment for London Trunk Dialling

In order to facilitate dialling and charging procedures as subscriber trunk dialling facilities (s.t.d.) are introduced, Post Office exchanges in the United Kingdom are being arranged in some 640 charging groups. Each group will have a central exchange with routing and charging equipment, to which will be allotted a national code number enabling it to be reached from any other exchange. By adding one or two digits to this code, other exchanges in the same group can be reached, and a particular subscriber will be called by following the exchange code with his local number.

As described in our January 30, 1959, issue, page 185, the digits dialled are transformed into a suitable form for routing the call in register-translators. In the London Director Area the register-translators are being centralised in one unit in Faraday Building, Queen Victoria Street, to which each exchange will be connected by direct junctions when it is provided with the s.t.d. facility. It was stated during an inspection of the installation on May 15 that 70 per cent of London trunk traffic originates within 3 miles of Charing Cross and will be dealt with by this equipment, which will come into operation on July 1. Subscribers on director exchanges will not dial direct into the centralised unit, but into a register at their local exchange (brought into action by the "0" digit which must precede all national codes). The number will be repeated from here to the centralised unit.

The bulk of the equipment at Faraday Building is electro-mechanical and was provided by Standard Telephones and Cables, Ltd. It consists of incoming relay sets with register access, of which there are 3526 (with wiring capacity for 4800), each relay set being associated with a two-motion first selector for connecting calls, under control of the register translators, either to an automatic trunk or toll switching unit or to second selectors for connection to direct trunk circuits to the central exchanges in fourteen of the largest towns. The second selectors, numbering 1300, are an A.E.I. high-speed motor-driven pattern. Five tariff pulse machines are installed for generating metering pulses. Each consists of groups of cam-operated contacts actuated by a motor-driven camshaft. Pulses, of 250 milliseconds duration, can be transmitted at twenty different repetition frequencies between 1¼ and sixty seconds. These are governed by the coincidence of certain contacts, the camshaft running at constant speed. Charging rates are selected according to the time of day by pulses from main or standby master clocks. These cause appropriate connections to be made to the terminal blocks on which the cam-operated contacts are cross-connected.

Six magnetic drum register translators have been installed initially, but there will eventually be eleven. These are of A.T.E./Sperry manufacture and each comprises a drum of 9in diameter and about 3¾in wide, revolving at 2160 r.p.m. The surface of the drum has forty-four tracks, of which six are used for registering the national numbers dialled by callers. Each of these six tracks contain eight registers. One is used for testing purposes and forty-seven can be for handling calls, but initially only thirty-eight or thirty-nine per drum have been equipped with connecting relay sets. Each register occupies about 2in of one track and this portion of track is associated electronically with one particular connecting relay set. Each register is electronically connected to its connecting relay set sixty times a second, when the impulsing lead is scanned to see if impulses are being received. The impulses are generated by cold cathode tubes. They are registered and every one-tenth second are recorded in the appropriate digit store. Impulses are added to the store by binary addition until an inter-digit pause occurs. The digit is then indicated as complete and the next one recorded in the next digit store. This continues until all digits have been received. National numbers can contain seven, eight or nine digits. After the seventh digit, therefore, the register times the next and if not received within four seconds it decides impulsing is complete. If an eighth digit is received the same procedure applies to the ninth and the register is then released to deal with other calls. Any temporary information it contained from the previous call is "overwritten" by the next call.

All registers can be in use simultaneously, and as digits must be written into and read off exact spots within 2in on a track revolving at 2160 r.p.m., and a translation must be written similarly into exact spots in the particular register requiring it, highly accurate timing is necessary. This is achieved by electronic clock circuits which are synchronised by a synchronising track on the drum.

Titanium for Submerged Pumps

For some time the I.C.I. Nobel Division has considered the possibility of using titanium for a pump handling 99·8 per cent nitric acid, believing that a pump using titanium would have a longer life and require less maintenance than one using 18/8/Nb. Stainless steel. As a result of discussions with Appleton and Howard, Ltd., the latter firm has designed and manufactured a pump in titanium which should require little maintenance, ensure reliability in service and safety while pumping highly corrosive acid since the gland would not be under liquid. With a submerged length of 8ft 9in, centre steady bearings were necessary along the support tube, and this difficulty was solved by employing pure P.T.F.E. bearings.

According to the latest information the "Gush" submerged pump made of titanium has been operating for about 7000 hours at 1440 r.p.m. and is still running smoothly with no noticeable vibration. The manufacturer, due to limitation in the size of pumps which can be lined, has departed from the traditional pump shape and has designed the unit to suit welded fabrication techniques: instead of relying on cast iron casing to provide strength the design uses a heavier gauge of titanium and stiffening ribs. This method, it is considered, removes any limit on the size of pump which can be built at an economic price. A range of horizontal pumping sets in the "Gush" series is now available with heads from 10ft to 150ft, and capacities from 2 to 2000 gallons per minute. All wetted parts are in solid titanium and have either packed glands or Crane 10 mechanical seals. When abrasive solids are present and a packed gland must be used, the titanium protective sleeve at the gland is coated with a minimum of 1mm of ceramic. Loaded P.T.F.E. bearings, with the loading in ceramic powder, stainless steel, nickel, glass carbon, can be fitted by the manufacturer, and the latest possibility is "Fluon" P.T.F.E. loaded with titanium. The loading of P.T.F.E. has reduced the bad cold flow habits, mainly due to the local heating effects of the rotating shaft, of pure P.T.F.E. and the Appleton and Howard bearings act as small heat exchangers ensuring even temperature throughout the bearing irrespective of the liquid level in the vessel.

[Reply Card No. E8282]

Appleton and Howard centrifugal chemical pump

Frequency and Capacitance Meter

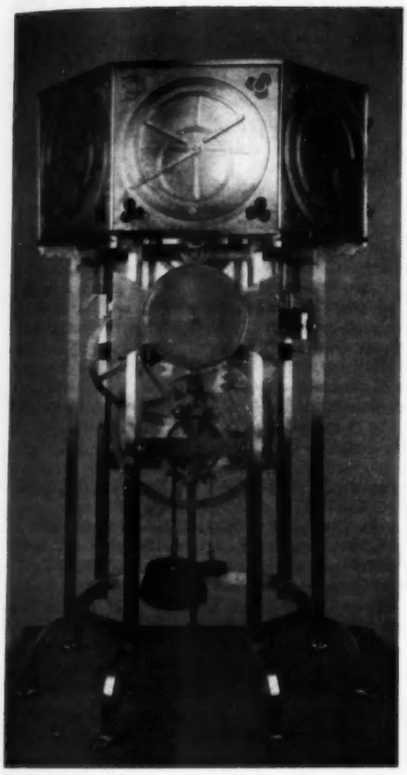
A portable, battery-powered meter for frequency and capacitance measurements has recently been produced by Solartron Laboratory Instruments, Ltd., Cox Lane, Chessington, Surrey. The meter gives direct readings of

Portable direct-reading meter for frequency and capacitance

frequency (0–100 c/s to 0–100 kc/s) and capacitance (0–1000 μF to 0–0·3 μF). As a frequency meter, the input signal (100mV–150V r.m.s. amplitude) is limited and fed into a pulse-counting integrator circuit. For capacitance measurement the instrument covers the range 0 to 0–3 μF in six ranges with a ±2·5 per cent accuracy maintained over the battery range 12V to 8V. The unknown capacitor is compared with the internal standard by substitution in the integrator circuit. The meter, MM1009, uses semiconductor devices throughout and is powered by eight Leakproof U2 cells (International Standard) or their equivalent, giving a useful operating life of three months. Overall dimensions are 6¾in by 9⅞in by 5½in, and weight is 6 lb.

Astronomical Clock on Exhibition

An astronomical clock, of modern construction but made to a design nearly 600 years old, is now on show at the Science Museum, South Kensington, London, S.W.7, where it will remain on public exhibition until June 25. It is said to be probably the most complex mechanical clock ever shown to the public. The clock is a reproduction of one designed and made by an Italian, John Dondi, between the years 1348 and 1364. It was the first clock to show, besides mean or clock time, the sidereal or star time and the motions of the sun, the moon and the five then known planets, all worked by an ordinary weight-driven clock movement. Its delicate and intricate brass gearing are remarkable, particularly since, as far as is known, the weight-driven clock was only introduced about fifty years earlier and the ordinary weight-driven clock was in Dondi's time, and for centuries after, of clumsy, forged iron construction.



Reproduction of Dondi astronomical clock of 1364

The various indications given by the clock are listed below, and in brackets the dates of the next known repetition of the particular indication :

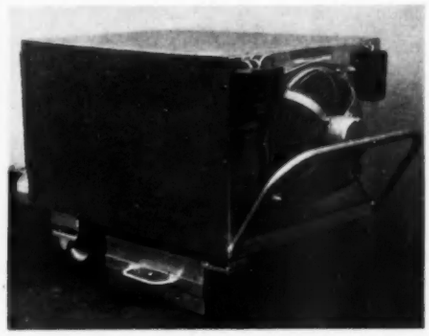
The hour.
Continuous indication and recording of minutes (1550).
Rising and setting of the sun (1450).
Daily length of daylight (1450).
Dominical letter*.
Fixed feasts of the church*.
Day of the month*.
Annual calendar wheel*.
Conversion of mean to sidereal time (1565).
Perpetual calendar for Easter (1842).
Trajectories of the five planets (1560).
Elliptical trajectory of the moon (1779).
Dial of the nodes (1550).

The original clock remained in Italy until 1585 and was then taken to Spain where, in 1809, it was destroyed in the Peninsular wars. Fortunately, Dondi left a Latin description of how he made the clock, with working drawings. This description was known to exist for centuries, but it was not examined horologically until the 1930s, when the late G. H. Baillie had it translated. Baillie's work has been completed by Mr. H. Alan Lloyd, who published a full description of the clock in 1955. He then decided to have a reproduction of the clock made, and found enthusiastic collaborators in Mr. Geoffrey Buggins, managing director, and Mr. Peter Howard, director and chief craftsman of the very old-established firm of clockmakers, Thwaites and Reed, Ltd., 15, Bowling Green Lane, Clerkenwell, London, E.C.1. After exhibition at the Science Museum the clock will be sent to the Smithsonian Institute, Washington, U.S.A.

* These may have been on the first Strasbourg Clock

Portable Industrial De-Humidifier

Designed for general use in the shipbuilding and shiprepairing industries, particularly painters, descalers, anti-corrosion specialists and other trades concerned with humidity, the " Dryzair " de-humidifier is of robust construction. The unit which is produced by O. N. Beck and Co., 30 West End Lane, London, N.W.6, has been designed around a standard Frigidaire ½ h.p. condensing unit using Refrigerant 12 and is mounted on a welded angle frame having a casing of aluminium sheet. A lifting handle in combination with four rubber tyred wheels, two of which are on castors, enables the machine, which has a gross weight of 554 lb, to be moved easily as required.



Portable industrial de-humidifier

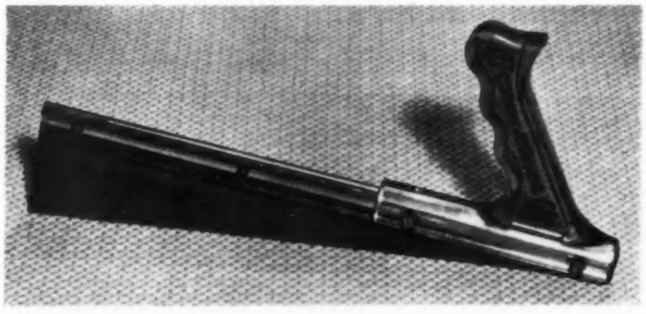
In operation moisture-laden air is drawn over the evaporator and cooled to a temperature below dew point and the condensed moisture is collected in a 5-gallon removable container. The extraction rate is about 5 gallons of water per twenty-four hours under a design condition of 55 deg. Fah., dry bulb temperature and a relative humidity of 80 per cent. The air is passed over the condenser and the dry bulb temperature raised and is heated by a thermostatically-controlled 3kW black heating element, which is set to warm the air should the temperature fall below 55 deg. Fah., but it can be adjusted to an upper limit of 70 deg. Fah. Then the dry warm air is dispersed and recirculated by a 12in diameter four-bladed fan rated to deliver 550 cubic feet of air per minute. The electrical connection is by a heavy-duty plug and the supply is 200V/220V or 230V/250V, single-phase, 50 c/s.

Reversible Locomotives

Following the statement in a paper read at the railway modernisation conference on May 3 and 4 (see our May 5 issue, page 747) that a new layout for British Railways type 1 locomotives to improve the convenience of one-man operation was under consideration, the British Transport Commission has announced an order for eighty-eight diesel-electric locomotives having the characteristics then referred to of a raised cab with low bonnets to give all-round vision. The type 1 power classification embraces locomotives between 800 h.p. and 1000 h.p. Designs hitherto have had an end cab and a single main bonnet structure enclosing the engine-generator set. In the new locomotives, which will be of 900 h.p., there will be a central full-width driving cab raised above and set between low bonnets of equal length housing separate engine-generator sets. This power class is used mainly on short-distance freight or local passenger trains, and twenty of the new series will be equipped with oil-fired carriage-heating boilers in the cabs. Previous type 1 locomotives have not had this heating system but they have been provided with steam pipes so that a leading locomotive with a boiler can heat the coaches of a double-headed train. All the new locomotives will be allocated to the Scottish Region.

The locomotives will be built by the Clayton Equipment Company, Ltd., at Hatton, Derby. This company was responsible for the mechanical parts and erection of a series of shunting and light passenger locomotives for the New Zealand Government Railways which had a similar central cab and power equipment layout (illustrated in our March 27, 1959, issue, page 506). Each locomotive of the British Railways series will be powered by two 450 h.p. engine-generator sets, one under each bonnet. The six-cylinder horizontal engines, having a maximum height of only 33in, will be supplied by Davey, Paxman and Co., Ltd. The contractor for the electrical equipment is The General Electric Company, Ltd. In normal service each main generator will supply power to two of the four traction motors, the locomotives having the B_0–B_0 wheel arrangement as in previous British Railways type 1 designs.

A further application of the central cab and two power unit layout is seen in the 600 h.p. " Taurus " diesel-hydraulic locomotive of the Yorkshire Engine Company, Ltd., now undergoing extended trials on British Railways and aimed at filling the gap between 400 h.p. locomotives for shunting only and the 800 h.p. to 1000 h.p. light mixed traffic range.



Sheet saw with 12in interchangeable blade

Sheet Saw

A sheet saw which provides a very useful addition to a craftsman's kit is the most recent addition to " Steadfast " range of tools made by the Darwins Tool Division of J. Stead and Co., Ltd., Manor Works, Cricket Inn Road, Sheffield, 3. This saw has a 12in triangulated blade of " Cobaltcrom " steel and is suitable for cutting steel, asbestos, plastics, wood, &c. in various forms including plain and corrugated sheet, tubes and blocks. Two blades of fourteen and twenty-four teeth per inch are provided to cover the requirements of different materials.

As can be seen in our illustration the saw has a plastics handle which is shaped to give an effective non-slip grip. The blades are locked by screws in the rigid backing bar or spine and are quickly and easily interchanged.

Visual Glide Path Indicators

VISUAL glide path indicators manufactured by The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2, for the V.G.P.I. landing aid system evolved by the Royal Aircraft Establishment, Farnborough, have been installed as part of the recent approach and runway lighting improvements at Luton Airport. This follows a smaller installation of four units set up last year by the G.E.C. at Southend Airport, using one indicator at each side of the runway at the beginning and at the end of the touchdown zone. In a full V.G.P.I. system, as at Luton, twelve units are disposed as wing bars of three units at each position. The inner unit of each bar is disposed about 50ft from the edge of the runway and the other two are spaced at roughly 17ft intervals out from that. With this arrangement the lights give enhanced roll or horizon guidance, as well as glide path information, down to the last stages of the approach. At Luton the first bars are 500ft from the runway threshold, and the intervals between them are 700ft at the west end and 500ft at the east end of the runway.

The G.E.C. ZA.707 unit (illustrated) for the V.G.P.I. system contains four " Osram " standard 200W lamps of the pattern used in approach lights and therefore available from stock on most airports. Units at Luton are operated through isolating transformers on two series circuits of six units. Each circuit feeds the units on one side of the runway, so that a circuit failure will still leave a downwind and an upwind bar in operation.

The lamps, with separate reflectors and all-glass colour filters, are mounted in a glass-fibre casing. For ease of maintenance the casing is split horizontally, with a lap joint to prevent water entering, and the cover is held in place by two rods which pass through brackets. Drains in the lower half remove any water that may blow in through the aperture. Moulded in the lower half of the casing are support studs which carry aluminium-alloy cross members near each end. The optical components—reflector/colour-filter assembly at the rear and aperture at the front—are bolted to the respective cross members. Reflectors are of anodised aluminium and, like the lampholders, are rigidly mounted. All adjustments are carried out at the works before despatch.

Height of the unit above ground has been kept within 10½in., thus complying with Ministry of Aviation requirement for elevated fittings near a runway. The unit is thus low enough to clear the propeller blades of an aircraft, even with burst tyres on one side, if it runs off the runway.

[Reply Card No. E8301]

Lever-Jack for Prestressed Concrete Roads and Runways

THE following note has been sent to us by the Road Research Laboratory :

The prestressing of concrete roads and runways is finding increasing popularity in this country and abroad. A common method is to use post-tensioned wires, bars or strand, and this requires gaps to be left in the concrete for the hydraulic jacks which tension the wires, &c. These gaps are a serious detriment to the method. They interfere with the flow of construction and weaken the road. A special lever-jack has recently been devised at the Laboratory with the object of reducing these gaps in size to smaller holes or slots. The principle of the jack is that the hydraulic rams which supply the tensioning force are kept above the surface of the concrete and the force is transmitted to the wires, &c., by levers as shown in the illustration. The end of one lever is fitted with grips to pull the wires, &c., and an attachment on the end of the other lever helps to position and drive the wedge of the permanent anchorage. The basic idea can be applied to any system of prestressing by post-tensioned wires, &c. The present jack is designed to tension one wire of 0·276in diameter with a force of 10,0000 lb and the jack weighs 85 lb. Similar jacks of reduced weight and with a greater force of tensioning are under consideration. The jack is the subject of U.K. patent application No. 16903/57.

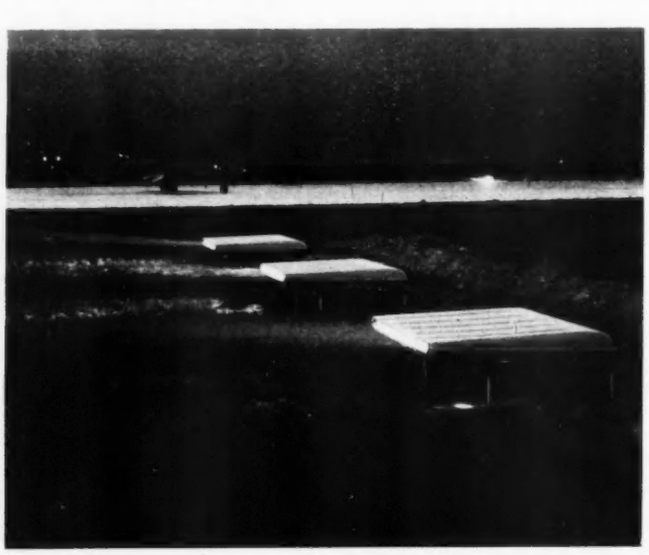
The lever jack in use

Shock Tests for Panel Instruments

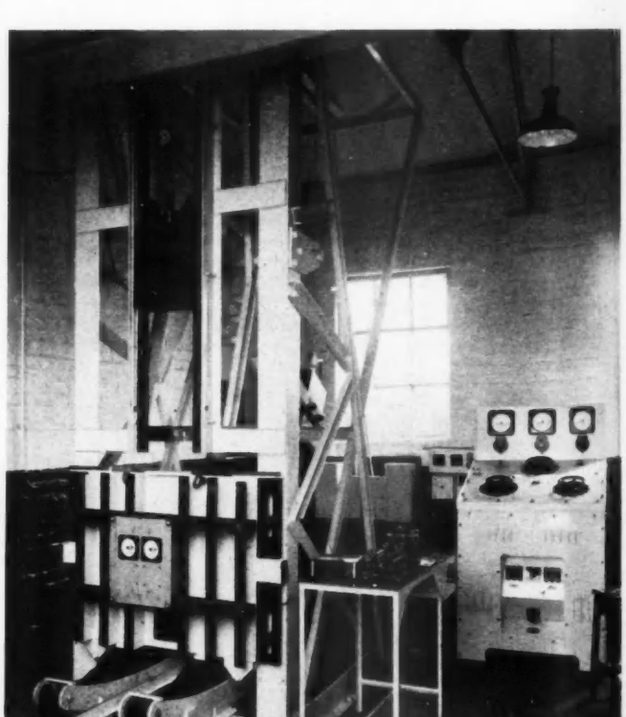
AMMETERS and voltmeters from the range of small Admiralty Pattern instruments made by Crompton Parkinson, Ltd., Crompton House, Aldwych, London, W.C.2, have been approved for use in fighting ships. They are stated to be the first of their size and kind to pass the Admiralty Shock Test necessary for this approval to be granted. These moving iron and moving coil instruments have 240 deg. circular scales and square or round bezels. Square bezel instruments have 2in dials with scales 3¼in long ; round bezel instruments have 2½in dials with scales 4¼in long. The die-cast metal cases are nitrogen-filled and sealed, and dimensions conform with Ministry of Defence Specification No. DEF-62.

We illustrate the apparatus used in the shock test, in which the frame carrying the instruments is struck by a heavy weight falling vertically and by a hammer swinging down from the rear. Shocks many times heavier than any likely to be experienced in normal industrial conditions were successfully withstood.

[Reply Card No. E8303]



(Above) Wing bar of V.G.P.I. units at Luton Airport



(Right) Falling weight and hammerblow equipment for Admiralty shock test of electrical measuring instruments

Industrial Films

THE colour film " Fair Oriana," produced for the United Steel Companies, Ltd., is available in both 35mm and 16mm sizes, and runs for twenty-eight minutes. It tells the story of the building, launching and commissioning of the 42,000-ton Orient liner " Oriana," the largest passenger vessel yet built in England. As an introduction there are shots of the ship undergoing trials ; some taken from the air are remarkably good photographically. The scene then switches to the Appleby-Frodingham steelworks, which supplied many thousands of tons of plate to the builders of the ship, Vickers-Armstrongs (Shipbuilders), Ltd.

Returning to the shipyard, the camera records the completion of the hull and the launching of the ship. Here again the camera angles and the photography are most effective. As fitting-out proceeds a record is made of the many different forms of steel which go into the building of a large passenger ship ; stainless steel for the galleys and for the cutlery (which was specially designed for the " Oriana "), steel strip for the many miles of water and other piping, and heavy forged steel for the propeller shafts. " Flashbacks " show the different types of steel being made and rolled or forged.

Finally, when the fitting-out is completed, the film shows the trials of the ship, with some detailed shots of the bridge, radio equipment and engine room. The last sequence in the film is of the " Oriana " leaving on her maiden voyage from Southampton to Australia, and here the photographic quality, always very good, excels. As the ship drops her pilot the sun is setting, and the use of colour film to show the brilliantly-lighted ship slowly disappearing into the gathering darkness is most effective.

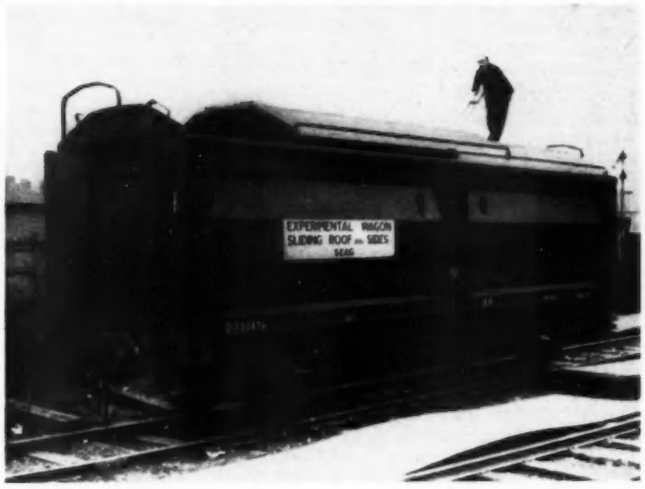
A second film, " Bond of Service " which was shown recently in London was commissioned by The Cement Marketing Company, Ltd., and gives an impression of the work and products of the Blue Circle Group. The film covers several aspects of the Group's activities, including research, demonstrator service, manufacture, distribution and export. The giant crusher at Hope is shown in action, and the different processes used at the post-war works at Cauldon and Shoreham are depicted. Some of the more advanced concrete constructions which have been built in Mexico by the architect and civil engineer Felix Candela, using cement produced by the Group's Mexican associated companies, are also shown. The film was produced by The Film Producers' Guild ; it is a 35mm colour film and runs for thirty minutes.

" Inside " is a 16mm colour film produced by the new De La Rue Film Unit, which describes the manufacture, testing and end use of " Formica " industrial material. The film was taken at the Tynemouth factory of Formica, Ltd., which is claimed to be the largest laminating plant in Europe. It shows not only the product and its manufacturing processes, but also the place where it is produced and the people who work there. The film emphasises the rigid quality control which is operated at every stage during the manufacture of " Formica " laminated plastic. It has been designed for trade and technical audiences in the plastics, electrical and allied industries. Copies of the film, which runs for twenty minutes, are available on free loan from Formica Public Relations Department, 84/86, Regent Street, London, W.1.

The British Petroleum Company, Ltd., has recently shown its new film " Service to Industry " in London. The film shows many aspects of the company's lubrication service to industry, such as the spectrographic analysis of crankcase oil from diesel locomotives in service, the development of special cutting oils for the aircraft and power tool industries, and co-operative tests on lubricants for free piston gasifiers. Primarily, however, the film stresses that to achieve economy as well as efficiency, the lubrication needs of all the plant in a factory should be surveyed so that an overall plan can be made which will enable the number of grades of oil and greases to be reduced to a minimum. The film is in 16mm and 35mm sizes and runs for eight minutes. A second film produced recently by the British Petroleum Company, Ltd., " The Hidden Power " shows some typical lubrication conditions in a number of different industries in various European countries, from dam building in the Swiss mountains to bottling beer in Holland. In the laboratory many of these conditions are reproduced to help in the development of lubricants with characteristics suitable for such conditions. The film explains something of the complexity of industrial lubrication problems and directs attention to the necessity of new research techniques to keep in step with industrial progress. The film is in 16mm and 35mm sizes and runs for twenty minutes.

Experimental Goods Wagons

Two covered wagons, equipped with sliding roofs and sides, are undergoing trials with British Railways in order to ascertain their suitability for British traffic conditions. The conversions, which are mounted on standard tube wagon underframes, were undertaken by the Powell Duffryn Engineering Company, Ltd., at its Cambrian Works, Cardiff, under licence from Rheinstahl Siegener Eisenbahnbedarf A.G. (S.E.A.G.), Westphalia, Germany. The latter company developed a sliding roof wagon in conjunction with the German Federal Railway, and later, in order to exploit the widespread use of fork-lift trucks, introduced sliding sides. Over 8000 wagons of both kinds are now in use throughout West Europe.



Operating one of the sliding panels of a covered rail wagon equipped for loading through the roof or sides

As seen in the illustration, the wagon body has two roof sections of light alloy and two side panels of mild steel, on each side of the wagon sliding one over the other to expose half the length of the body at a time. All sections can be opened or closed by one man in a matter of seconds, and be secured against unauthorised entry. Examples of how these facilities may be used are the direct transfer of freight from a ship's hold into the wagon body from above, and the loading of palletised goods by fork-lift trucks from the side. In both cases loading can take place along the whole length of the body.

Work studies carried out by the German Economic Efficiency Council have shown that : (*a*) it took four men and one fork-lift truck operator 875 minutes to load 20 tons of palletised carbon electrodes into a normal covered wagon, while one man and one fork-lift truck operator loaded the same freight in 37 minutes into the new wagon ; and (*b*) a 15-ton load of piece goods was unloaded from above by gantry crane in 30 minutes from a sliding roof wagon, but it took 180 minutes to unload the crates from a normal covered wagon.

Powder Mixing Machine

A MACHINE which has been designed for the effective, high-speed mixing of powdered material by means of an air blast has been developed by W. Gardner and Son (Gloucester), Ltd., Bristol Road, Gloucester. These " Airmix " machines are made in a number of sizes with working capacities from 2 to 800 cubic feet.

The vertical cylindrical body into which the powders to be mixed are deposited has a conical lower section with a mixing head at the base. This mixing head has round its inner circumference a number of specially shaped nozzles, It is claimed that complete homogeneous mixing of a powder charge has been achieved by a series of eight air blasts, each of two seconds duration with a one second period between.

A filter assembly at the top of the body consists of a series of replaceable and easily cleanable textile filters which project down from the top cover into the interior. The whole of the filter system is vibrated during the operation of the machine to shake the filters clean as the mixing takes place.

After mixing, the machine is rapidly emptied by the operation of a valve fitted to the mixing head. The whole machine can be cleaned rapidly by an air blast from the nozzles to sweep any material adhering to the walls and deposit it into the outlet. When changing over from one mix to another the only portions of the machine which normally require manual cleaning are the textile filters and these can be quickly removed, cleaned and be replaced. The machine is supplied with a simple electric timing unit which can be preset to give the total mixing time, and the duration and interval between the blasts of air. In addition to the use for the mixing of dry powders, modifications can be made to the machine for its use as a combined mixer and sprayer to enable liquids to be added to powders and mixed with them.

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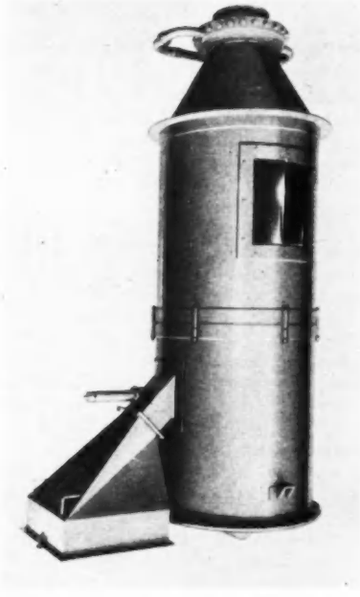


Machine for mixing powders by air blast

INDUSTRIAL NEWS

Machine Tools

The monthly report on metalworking machine tools issued by the Machine Tool Trades Association shows that the value of net new orders received by the industry in February this year, £9,360,000, was below the high figure for January, but this was probably the result of random variation in the timing of orders, the Association says. Net new orders received in the first two months of 1961 were 5 per cent less than a year earlier and at about the same rate as in the second half of 1960.

Deliveries during the shorter month of February were valued at £9,140,000, which was only slightly less than in January and was 17 per cent higher than in February, 1960. There was little change in the value of orders on hand at the end of February, the Association states; home market orders have been valued at £84,556,000 and orders for the export market at £24,788,000.

Oil Consumption in 1960

The Petroleum Information Bureau has published particulars of oil consumption in the United Kingdom for 1960: these show that the overall consumption rose by 16·9 per cent over the 1959 figure to reach a total of 42,696,037 tons. The corresponding totals for 1938 and 1948 were 8,990,686 tons and 12,766,025 tons respectively. Fuel oil showed the greatest increase, rising from 13,811,874 tons in 1959 to 17,437,805 tons, while gas/diesel oil at 3,540,158 tons represented an increase of 13 per cent. A further advance of 7 per cent to 7,625,184 tons was made in the consumption of motor spirit and demand for derv increased by 13·5 per cent to 2,582,186 tons. Total kerosene deliveries remained unchanged at 1,584,116 tons, the increase in use of burning oil being offset by the decline in demand for vaporising oil. The returns show a remarkable increase of 46 per cent in deliveries of chemical feedstock to a total of 1,562,060 tons and also record that lubricating oils and bitumen absorbed about 1,000,000 tons each.

Rating Revaluation and Shipbuilding

Grave concern has been expressed, at a recent meeting of the Shipbuilding Conference, concerning the effect on the industry's competitive position of the additional costs involved by revaluation and industrial derating. In Scotland the new assessments represent enormous increases, of which the largest apply to yards which have invested a large amount of capital on modernisation schemes designed to reduce costs and improve competitive strength. One firm, presently paying £9000, was stated to be faced with paying rates of £100,000 in 1963. The Shipbuilding conference feels that, at a time of severe competition, to penalise in this way firms which have accepted the challenge of foreign competition is the antithesis of incentive. Furthermore, the Conference declared, it is contradictory to impose additional costs, and so adversely affect competitive strength, while urging greater export efforts, particularly so with the shipbuilding industry which attracts high rating due to its costly production equipment in the form of slipways, fitting out berths, dry-docks and cranes.

Agricultural Machinery and Tractors

The current issue of *Trend Review*, published by The Agricultural Engineers Association, states that in the first quarter of this year overall output in the agricultural machinery and tractor industry was higher by a " slender " 2 per cent. The only sector to show a substantial gain, the Association says, was that of combine harvesters, where production was nearly 20 per cent higher than in the corresponding period last year. The production of implements was 1 per cent higher, whilst tractor production advanced by a little over 2 per cent.

Sales moved ahead faster than production, the Association points out, in both home and overseas markets. At home the rise was greater than in overseas sales for the first time in many months, the rise of 7 per cent being largely accounted for by an unusual growth in combine harvester sales, which were some 85 per cent above last year's level. Implement sales were down in comparison with the first quarter of 1960, but this was offset by a similar gain in tractor sales.

Exports were just over 6 per cent higher, the Association says, tractors showing an increase of 3 per cent and implements of 3 per cent, whilst combine harvesters showed a drop of 63 per cent.

Trading Opportunities in Europe

The report of a series of fact-finding missions organised by the Export Council for Europe in nine countries earlier this year has now been published. The countries visited were Austria, Denmark, France, Italy, Norway, Portugal, Spain, Sweden and Switzerland. The missions have investigated both the present and the potential opportunities for British firms to export to Europe, and have produced a survey of their findings.

In a section on the " trading pattern " in Europe the report suggests that the extent to which post-war economic development has increased present and potential purchasing power in Europe has not been fully appreciated in Britain, and that intensive effort to meet specific demands is now more than ever worthwhile. In its remarks on delivery and service, the report says that although the Channel provides an obstacle for the easy transport of British exports to Europe, this handicap is not insurmountable with modern development of ferry services and air freight. This is a problem demanding immediate attention, the report adds, and any means of by-passing this obstacle, or surmounting it more efficiently, would assist in speeding up delivery and service.

Iron and Steel

The Iron and Steel Board announces that steel production in April, which was affected by the Easter holiday, was at an average rate of 471,600 tons a week. This was slightly above the March figure of 471,000 tons a week and below the 478,100 tons a week recorded in April, 1960. The production of pig iron was at an average rate of 308,400 tons a week, which was a little below the March figure of 313,500 tons a week, but was equal to the average for the first quarter of the year.

Returns so far received from the census of steel stocks taken at the end of March cover about half the total use of steel, and suggest that during the first quarter of the year the total stocks of steel held by users and merchants were still rising, although the estimated increase of 60,000 tons was considerably less than the rise of 250,000 tons a quarter throughout 1960. If the rise in stocks so far indicated is representative of the whole field, the Board says, the use of steel in the home market during the first quarter can be assessed at a seasonally-corrected figure of 3,720,000 tons.

Deliveries of heavy steel during the first quarter of 1961 showed an upward trend, and in the case of plate in particular, the Board states, there was a substantial rise, with an appreciable tonnage coming from the new mills recently completed on the north-east coast.

Civil Engineering

In the annual report of the Federation of Civil Engineering Contractors which has just been published, Mr. A. J. Hill, the chairman, points out that the civil engineering contractors, demands for more work remain unsatisfied, and this is in spite of a continued increase in the volume of construction work, mainly industrial and commercial, during a year when economic activity generally was restricted. The Government's acceleration of the road programme is welcome as a step in the right direction, Mr. Hill says, but there is much more to be done in the public development of the country. Schemes for water supply, sewerage and flood prevention are long overdue, and Mr. Hill urges the Government and public authorities to recognise and act upon the necessity of keeping such works abreast of other forms of capital investment.

The report records that the Federation has, through the National Consultative Council and the Regional Committees of the Ministry of Works, kept the Government aware of the shortage of the smaller type of civil engineering jobs. A special *ad hoc* committee of the Federation was formed during the year to study the problem. It was found, the report says, that in general more invitations to tender for the smaller type of local authority contract were being issued, but the shortage in some sections continued to be serious.

The report goes on to suggest that, as the interest rates charged to local authorities are unlikely, in modern conditions, to be much diminished, an increasing number of local authorities might therefore be expected to proceed with schemes which were being delayed in the hope of the rates being lowered.

Speaking at the annual dinner of the Federation, Mr. W. G. Mitchell, the president, drew attention to the close co-operation between the Federation, the Institution of Civil Engineers and the Association of Consulting Engineers. In conjunction with the Minister of Education, he said, they were at present " hammering " out a scheme for the training of technicians which would provide a career for men who, although not perhaps possessing the academic ability to obtain full professional status, could nevertheless make a great contribution to the industry if given some sort of recognition and training.

PERSONAL AND BUSINESS

Appointments

MR. W. E. PRIOR has been re-elected chairman of the British Mechanical Rubber Manufacturers' Association for 1961–62.

CROFTS (ENGINEERS), Ltd., announces the appointment of Mr. John R. Mitchell as technical representative for the Sheffield area.

THE WAYNE KERR LABORATORIES, Ltd., has appointed Major E. R. Wilcox to the post of research and development liaison officer.

SOLARTRON LABORATORY INSTRUMENTS, Ltd., has appointed Mr. Norrie McFarlane as regional manager covering Scotland and Ireland.

MR. LESLIE PATE has been appointed general sales manager of QVF, Ltd. Mr. John Linnell has been appointed home sales manager.

MR. A. R. CROFT has been appointed chief designer of Conveyancer Fork Trucks, Ltd., in succession to the late Mr. J. D. Coldwell.

MR. THOMAS MURRAY has been appointed industrial safety officer for the Bradley and Foster group of seven companies in Staveley Industries, Ltd.

MR. L. A. C. FULLER has been appointed to the board of Taskers of Andover (1932), Ltd. He took up his position as assistant to the managing director on May 1.

MR. CLIFFORD S. SHAW, M.I.Mech.E., has been appointed assistant managing director of R. H. Neal and Co., Ltd., of Grantham, one of the Steel Group of Companies.

JESSOP-SAVILLE, Ltd., announces the appointment of Mr. G. T. Harris, F.Inst.P., as assistant managing director. The appointment of Mr. J. G. Ryder as a director is also announced.

BAILEY METERS AND CONTROLS, Ltd., has appointed Mr. R. Pearson as sales engineer for Scotland, Northumberland and part of County Durham. He will assume his duties early in June.

MR. H. H. H. HELBY has been re-elected chairman of the British Wrapped Rubber Hose Manufacturers' Association for 1961–62. Mr. D. P. G. Moseley has been re-elected vice chairman.

MR. E. W. HERRINGTON, M.I.Mech.E., M.I.H.V.E., has been appointed engineer in charge of the mechanical and electrical service department of the industrial division of E. G. Irwin and Partners, Ltd.

STUBS WELDING, Ltd., has appointed Mr. R. Gibson to represent the company in Manchester and Central Lancashire. Hs is taking over the territory from Mr. B. T. Bibby who has been promoted to district sales manager in the Midlands.

THE MINISTRY OF AVIATION states that Professor George Temple, F.R.S., Professor of Natural History, University of Oxford, has been appointed chairman of the Aeronautical Research Council in succession to the late Professor W. J. Duncan.

MR. R. DINGWALL, chief engineer, and Mr. W. V. GOLDING, raw materials and transport superintendent of Dorman Long (Steel), Ltd., have been appointed special directors of that company and also of the parent company, Dorman, Long and Co., Ltd.

THE ELECTRICAL DEVELOPMENT ASSOCIATION announces that Sir Edwin Herbert has been reappointed President for 1961–62, that Mr. R. R. B. Brown has been elected chairman of the council and that Mr. D. H. Kendon has been elected vice-chairman.

MR. J. H. THORNTON, M.I.C.E., has been appointed group resident superintendent for the 580MW nuclear power station at Sizewell, Suffolk, which is being built for the Central Electricity Generating Board by the English Electric, Babcock and Wilcox, Taylor Woodrow atomic power group.

MR. P. E. ROUSSEAU, managing director of the South African Coal, Oil and Gas Corporation, Ltd., has now been appointed chairman of the Corporation in succession to Dr. F. J. Du Toit, who died recently while on a trade mission to the Far East. Mr. Rousseau continues as managing director for the time being.

THE SOCIETY OF MOTOR MANUFACTURERS AND TRADERS states that Mr. D. G. Stokes has been elected president for 1961–62, in succession to the Hon. Geoffrey Rootes who now becomes deputy president. Mr. L. G. T. Farmer and Mr. G. E. Liardet have been elected vice presidents in succession to Mr. M. A. H. Bellhouse and Mr. Stokes.

MARCONI'S WIRELESS TELEGRAPH COMPANY, Ltd., announces that Mr. F. S. Mockford has relinquished his appointment as commercial manager in order to undertake special duties for the managing director. Mr. F. Wheeler has been appointed commercial manager and Mr. H. Baker has been appointed deputy commercial manager.

LONDON TRANSPORT has announced the following changes in the organisation of the department of the chief mechanical engineer (railways) : Mr. I. W. Standring, A.M.I.E.E., mechanical engineer (lifts and escalators), has become contracts officer in the works and contracts division at Acton ; Mr. E. P. Lumley, M.I.E.E., M.I.Loco.E., assistant mechanical engineer (works-railways), has become mechanical engineer (lifts and escalators).

R. W. CRABTREE AND SONS, Ltd., has announced that Mr. Charles Crabtree has relinquished the managing directorship he has held jointly with his son for the past few years. He remains as chairman of the board. Mr. A. Rayner has been appointed joint managing director with Mr. Peter Crabtree. Mr. H. E. Birkinshaw, company secretary, Mr. J. M. Lougee, a director of the Hoe company in London, and Mr. A. Bain, managing director of the Bren Manufacturing subsidiary, have also been appointed directors of the parent company's board. Mr. Harold M. Taylor, a director, has resigned owing to ill-health.

Business Announcements

HAWKER SIDDELEY AVIATION, Ltd., announces that it is to endow a readership and lectureship in noise and vibration research at the University of Southampton.

W. H. ARNOTT, YOUNG AND CO., Ltd., Brookside Tube Works, Middleton-St.-George, Darlington, states that its telephone number has been changed to Dinsdale 342.

BRITISH INDICATORS (SALES), Ltd., St. Albans, Herts, has been granted a licence by the British Standards Institution to apply the Kite-mark to its range of dial gauges for linear measurement manufactured in accordance with B.S.907.

WATERMASTERS (PTY.), Ltd., Johannesburg, South Africa, is to produce and market in South Africa, plant designed by William Boby and Co., Rickmansworth, Herts. The agreement between the two companies applies to the whole range of Boby water treatment equipment.

MOFFAT AND BELL, Ltd., has moved its offices to 83, Pall Mall, London, S.W.1 (telephone, Whitehall 4038). The company is agent for Lindemann K.G., Düsseldorf, and users requiring spares for these machines should contact the company at 79a, Blythe Road, W.14 (telephone, Riverside 8891).

TEMPERED GROUP, Ltd., Sheffield, has acquired the entire issued share capital of Henry Rossell and Son, Ltd., Effingham Street, Sheffield, 4. The new board of directors of Rossell's will comprise : Mr. Gerard Young, Mr. Hugh Young and Mr. C. Graham Murray. Mr. K. G. Settle will continue as secretary.

THE REED PAPER GROUP announces that the recently formed joint subsidiary of Albert E. Reed and Co., Ltd., and La Centrale Finanziaria Generale S.p.A., of Milan—Sicar, S.p.A.,—has acquired the majority of the shares of the Rexim-Bugnone S.p.A., packaging business in Turin. This is the Reed Paper Group's first operating company in the European Common Market.

SIMMS MOTOR AND ELECTRONICS CORPORATION, Ltd., announces that it has taken a 50 per cent. interest in Cold Point, Ltd., a Bahamian company which owns the world (excluding the U.S.A. and Puerto Rico) rights to manufacture and sell a range of engineering small tools originally patented in the U.S.A. Simms' main partner in this venture is E.D. Sassoon Banking Company, Ltd., of Nassau, Bahamas, who was responsible for the acquisition of the rights. Manufacture of the new products is to be carried out by Horstman, Ltd., of Bath, Somerset, a Simms subsidiary, and the development and marketing will be undertaken by Coldpoint Drills, Ltd., a wholly-owned British subsidiary of Cold Point, Ltd., with registered offices at Oak Lane, East Finchley, London, N.2, and a sales office at 49, St. James's Street, London, S.W.1. The directors of Coldpoint Drills, Ltd., are : Mr. G. E. Liardet (chairman), Mr. J. Ayres, Mr. E. Biddlecombe, Mr. W. T. Daly, and Mr. J. J. Robertson. The secretary is Mr. A. J. Bryson, F.C.A.

Contracts

BLAW KNOX CHEMICAL ENGINEERING COMPANY, Ltd., has received a contract from Bexford, Ltd., for the design and construction of a plant for the production of polymer at Manningtree, Essex.

FLUOR ENGINEERING AND CONSTRUCTION COMPANY, Ltd., is to carry out the detailed engineering and procurement of Svenska Esso's steam cracking plant to be built at Stenungsund, Sweden, for the production and recovery of ethylene and butadiene.

DAVEY, PAXMAN AND CO., Ltd., has received a contract to supply the propulsion and electrical generating machinery for the two ferry boats for the Victoria to Vancouver service. Each vessel will be powered with four sixteen-cylinder engines developing a total of 6000 s.h.p. and three 1500kW generators driven by twelve-cylinder diesel engines.

HOLLOWAY BROTHERS (LONDON), Ltd., has started construction on a 3 acre site at Purfleet, Essex, for Thames Board Mills, Ltd. This £1,450,000 contract includes buildings to house a new packaging board machine, which will have an initial production of 80,000 tons of board a year. The work is due to be finished by the summer of next year, and the consulting engineers are Frederick S. Snow and Partners.

FOSTER WHEELER, Ltd., has received a contract from the British Petroleum Company, Ltd., for the design, engineering, supply and construction of the process units for the lubricating oil plant at the Kwinana refinery. The units are : vacuum distillation unit ; furfural extraction unit ; M.E.K.-Tolnene dewaxing unit ; and the ferrofining (hydrofinishing) unit. For carrying out this work Foster Wheeler, Ltd., has formed an association with Constructors John Brown Australia (Pty.), Ltd.

Miscellaneous

LIFT AND PROPULSION ENGINE.—The Bristol Siddeley BS-53 ducted fan engine with separate rotable nozzles for the fan and turbine effluxes is now to be called the " Pegasus." This name was previously borne by a poppet-valve radial engine built by the Bristol Aeroplane Company, Ltd.

HEAVY FREIGHT AIRCRAFT.—On page 784 *ante* the Short " Belfast " was described as the erstwhile " Britannia ." This should, of course, have read " Britannic " ; the latter differs extensively from the former, having a large cargo-carrying hull to which the undercarriage bogies are attached, a centre section added to the wing, and " Tyne " engines instead of the original Bristol " Proteus " power plant.

CENTRE FOR " CATERPILLAR " PLANT.—A new establishment which incorporates an adminstrative headquarters, a central servicing workshop and a spare parts store for " Caterpillar " earthmoving equipment has been opened on a 13½ acre site in Watling Street, Cannock, by Bowmaker (Plant), Ltd. The stores concerned with the supply of spare parts covers an area of 21,000 square feet and is laid out with facilities for the storage and handling of the 350,000 items which are maintained in stock. The workshop, 120ft wide by 275ft long, is fully equipped for the overhaul and repair of tractors and earth moving plant.

BRITISH MINING TOOLS ASSOCIATION.—A new body, the British Mining Tools Association, was set up in January by thirty-three firms engaged in the manufacture of tungsten carbide mining tools, tips for mining tools, or of raw materials or blanks used in the manufacture of mining tools. To cater for the various interests of the members, the activities of the Association have been divided into four sections concerned with coal tools, percussive tools, carbide tips, and raw materials and blanks. This new organisation has been set up to enable interested manufacturers to co-operate with each other on common technical problems concerning mining tool specifications as well as to co-operate technically with other organisations in the interests of the industry as a whole. The Association also intends to play an active part in the domestic and international standardisation fields. The secretary of the Association is Mr. E. A. Tuxford, Light Trades House, 3, Melbourne Avenue, Sheffield, 10 ; its president, Mr. H. Eckersley, of Wickman, Ltd. ; and its vice-president, Mr. E. A. Martin, of Padley and Venables, Ltd.

CONTINENTAL AFFAIRS

by Our Continental Editor

German Industries Fair at Hanover

No. II—(*Continued from page 758, May 5, 1961*)

Salzgitter

As a development of its overhead loader, Salzgitter Maschinen Aktiengesellschaft, Salzgitter-Bad, exhibited a side tipping loader (Fig. 4) which is intended chiefly for use with belt conveyors in mines where its low headroom requirements (2150mm to 2650mm) are of advantage. A tracked or rail-mounted vehicle of 5·9 tonnes, the machine is powered by two 9 h.p. propulsion motors which give it a speed of up to 0·7m per second and a 13 h.p. motor for the loader mechanism, all operated by compressed air at 4·5 atmospheres gauge or electrically. The 600-litre shovel can be arranged for discharge towards either side, and is stated to be able to climb gradients of about 1 in 4·3 (24 per cent) with a full load. Conversion into an overhead shovel or overhead bunker loader is possible.

Messier

The Messier Company, 58, Rue Fénelon, Montrouge (Seine), showed various designs of servo motor, with output position or speed depending upon the duration and the magnitude of the control current. The devices, which are stated to have a high degree of accuracy, are intended for the operation of valves, locks, control surfaces and similar technical applications. The force exerted is from 150 kg to 1000 kg depending upon the design and speed of operation, the latter varying between 2mm and 15mm per second. Depending upon the model, the stroke is up to 200mm, with power supplied by 220V/380V, 50 c/s motors with d.c. or or a.c. controls.

Benno Schilde

For cleaning and degreasing cup-shaped articles or components with blind holes, Benno Schilde Maschinenbau A.G., Bad Hersfeld, has introduced a drum washer in which the articles are rotated and thereby thoroughly exposed to the cleaning medium at 50 deg. to 80 deg. Cent. A preliminary drum to which the components are fed by hand or conveyor spreads them out and by means of a helix they are taken into the washing drum proper. This is followed by one or more rinsing stages, a phosphating bath, or a drying stage, as may be required.

Theodor Klein

The firm Theodor Klein G.m.b.H., Ludwigshafen a. Rh., showed fully automatic, oil-fired industrial space heaters for positioning under the roof of the workshop. The heated air is blown downwards by an electric fan. A fuel saving of up to 30 per cent is stated to be obtainable owing to the fact that use is made of the hot air which normally collects near ceiling level. The equipment can be adapted to serve as ventilator or extraction fan.

Robert Bosch

Gear pumps with a volumetric efficiency of 98 per cent at 150 atmospheres gauge—96 per cent if used as a motors—were shown by Robert Bosch G.m.b.H., Stuttgart. These pumps can be used—also as motors—up to 175 atmospheres gauge with SAE10 to 20 hydraulic oils at temperatures up to 80 deg. Cent. Fig. 5 shows the characteristics of a pump delivering 32 litres per minute at 2000 r.p.m. Overall pump efficiencies of up to 95 per cent and motor efficiencies up to 92 per cent are claimed to have been achieved. It is stated that the gear motors can start against 60 per cent full nominal torque.

These remarkable improvements have been achieved by supporting the rotors in hydraulically self-adjusting bearings, so-called lunette bearings, whence the name lunette pumps for this design.

Analysis of the traditional gear pump shows that the volumetric efficiency is reduced by leakage across tips and along the flanks of the gears. Wear of the rotating parts soon enlarges the very small clearances which can be tolerated: leakage across the teeth leads to a large part of the circumference on the discharge side being under pressure. The result is a great increase in the load on the bearings and loss in mechanical efficiency due to friction. Compression of oil between meshing gear teeth entails further mechanical losses.

The principle by which these undesirable aspects may be overcome will be understood by referring to Fig. 6. This shows one of the two twin bearings which support the meshing rotors on either side. These are under inward axial pressure, so that the clearance across the gear faces is kept small. There is, however, a certain amount of "give" so that dirt particles can escape without causing scour. Through boreholes such as *F*, oil from the pressure side is admitted to pressure pads *A*, *B*, and *C* situated

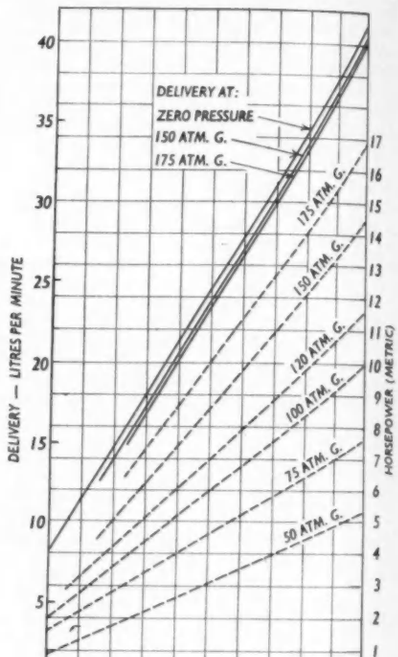


Fig. 5—Characteristics of lunette pump, model HY/ZFR 1/32. Power curves for a delivery of 32 litres per minute—Robert Bosch

on the circumference. Kerfs at *D* and slits at *E* permit the outer parts of the bearing to deflect inwards under the pressure, thus counteracting the effect of the oil pressure on the delivery side. Radial clearance is reduced to the extent that one or two teeth can maintain an adequate seal. The remainder of the circumference is drained through recesses to the suction side. The pressure zone is therefore practically confined to the area of the delivery port, and the load on the bearings is very substantially decreased. This state of affairs is further improved by splash lubrication through the slits *E*, rather than using for this purpose the oil compressed between meshing

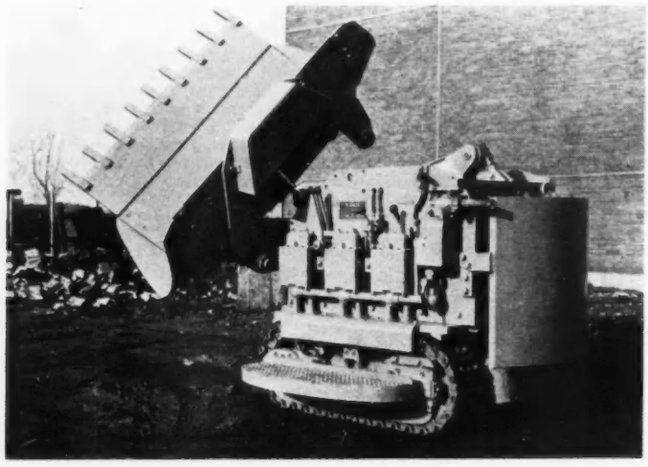


Fig. 4—600-litre side-tipping power shovel—Salzgitter Maschinen

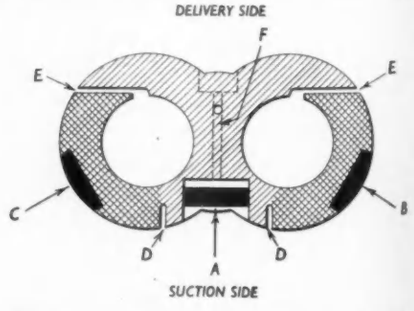


Fig. 6—Lunette gear pump bearing, illustrating manner of compensating for the pressure on the delivery side. Oil pressure at A forces the whole bearing upwards, while pressure at B and C deflects the cross-hatched sections inwards—Robert Bosch

teeth which instead is drained into the pressure space through grooves in the bearing faces.

It is, of course, essential not to allow the action of the lunette bearings to be disturbed by external forces on the drive shaft. The standard design therefore requires to be driven through a flexible coupling ; to a lesser extent a gear drive is possible. A version with an intermediate bearing is also available which is suitable for any kind of drive including vee-belts.

Towler Brothers

At the stand of Towler Brothers (Patents), Ltd., Electraulic Works, Rodley, Leeds, was shown a variable hydraulic transmission with a maximum displacement of 68 cubic inches per second at 1500 r.p.m., and a working pressure of 3500 lb per square inch capable of withstanding overloads of up to 5000 lb per square inch. The fixed unit can be supplied with one of four fixed swash angles to give maximum continuous torques of 1100 lb to 1750 lb in in at 1500 r.p.m. Maximum speeds are 2000 r.p.m. as pump and 3000 r.p.m. as motor.

Also exhibited was a moving coil electric control valve for high-speed hydraulic controls which can operate in 5 milliseconds at 1000 lb per square inch. This valve is available for continuous working pressures up to 3000 lb per square inch as a single- or double-acting unit with capacities of 68 cubic inches per second.

Fried. Krupp

This year the emphasis at the stand of the Krupp concern was on civil engineering and equipment for mining and materials handling. The principal exhibit by Fried. Krupp Maschinen-und Stahlbau Rheinhausen was a section of an elevated roadway which this company has developed jointly with other structural engineering firms (Fig. 7). The exhibit included a straight approach ramp and a curved exit ramp. The principle is that of compound construction, comprising a steel trough supporting a concrete deck, the whole resting on a single line of tubular columns. In this design, both the trough sections and deck slabs are prefabricated and of a size and weight—4 to 5 tons—suitable for erection with the help of a mobile crane. The deck slabs, which are provided with only plain reinforcement, cantilever over the edge of the trough on either side. They are connected to the trough by high-tensile bolts, thus doing away with the usual shear connectors which have to be embedded in concrete *in situ*. This leads to exceptionally short erection times and reduces the effect on the completed structure of shrinkage and creep.

Fig. 8—Mobile limestone crushing plant—Fried. Krupp

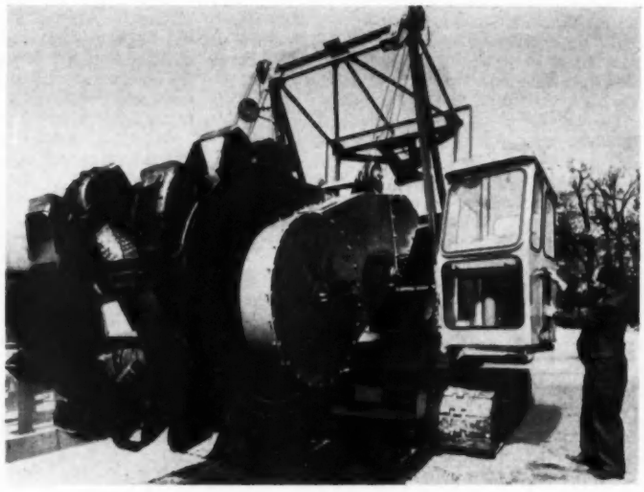


Fig. 9—Bucket wheel excavator for clay pits and small construction sites. The machine has a capacity of 75 cubic metres per hour—Fried. Krupp

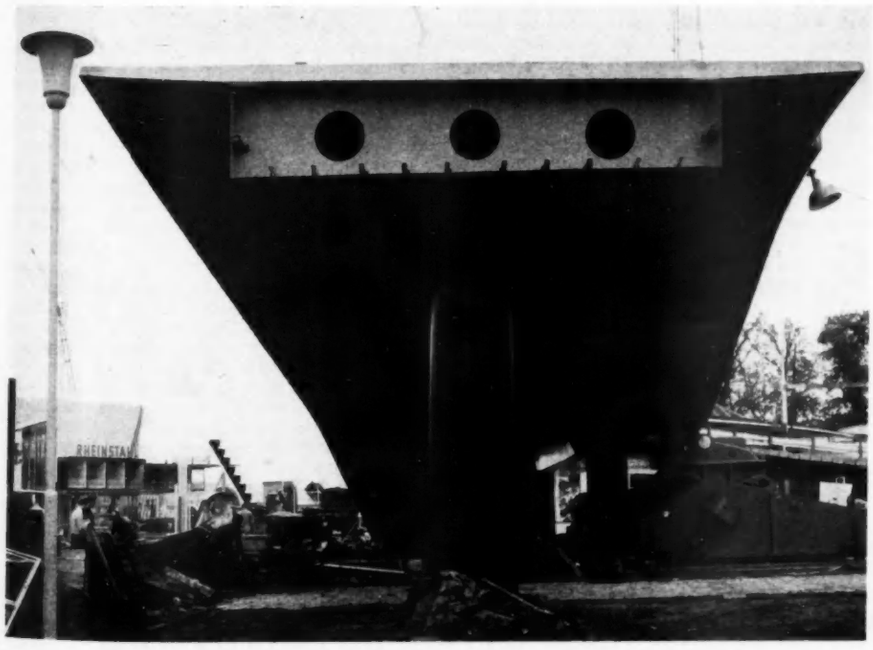


Fig. 7—Prefabricated elevated roadway in bolted compound construction—Fried. Krupp

The same maker also showed a mobile limestone crushing plant capable of dealing with sizes up to 800mm with an output of 250 tonnes per hour (Fig. 8). The plant is mounted on tracks and is electrically operated. It consists of a feed hopper, belt feed conveyor, single-shaft hammer mill, and discharge conveyor. Feeding is by power shovel.

Especially built for use in claypits supplying brickworks and similar industries the small bucket-wheel excavator shown by Maschinen-und Stahlbau Rheinhausen is stated to be particularly useful for the selective digging of stratified material (Fig. 9). To enable it to cut tough clay it has been equipped with a heavy duty drive for its two side-discharging bucket wheels which are arranged on either side of the conveyor. Each wheel is fitted with six buckets and additional cutters for breaking the cut material. Bucket-wheel boom and conveyor boom can be slewed independently of each other. The machine is stated to have a capacity of 75 cubic metres per hour.

Siemens

A representative cross-section of its production programme was shown by the Siemens concern at the main exhibition stand in Hall 13 (Siemens & Halske and Siemens-Schuckertwerke) and in Halls 10 and 11 where Siemens-Electrogeräte A.G. showed domestic equipment and radio and television sets.

CONTINENTAL AFFAIRS *(Continued)*

This was the first time at a German fair that a nuclear reactor was shown complete and in full working order. The "SUR 100" made by Siemens-Schuckertwerke is specially designed for teaching and demonstration purposes as well as for nuclear measurements and as a source of radiation. It has a continuous rating of 0·1W and maximum thermal neutron flux of 5×10^{6}n per square centimetre per second. Models with a ten-times and a 100-times larger output are available. The design of the "SUR 100" is such that it can be installed in existing laboratories without big structural alterations and can operate in full safety.

The core consists of a homogeneous mixture of U_3O_8 powder as fuel and polyethylene as moderator, in the form of cylindrical plates of 24cm diameter and a few centimetres high which are stacked to a total height of about 26cm. The uranium oxide is 20 per cent enriched in U235, the critical amount of the fissile isotope being about 700 grammes. The core is surrounded by a 20cm-thick graphite reflector and shielded by 10cm of lead and 60cm of water containing boric acid. Immediately outside the outer steel tank the radiation dose is below the tolerance limit of 2·5 millirem per hour. The inner core is closed with a steel baseplate, the space below being accessible through a door filled with boric acid solution. The core plates are inserted from above and afterwards the top is closed with an aluminium lid.

Because of its negative temperature coefficient of -3×10^{-4} per degree Centigrade the reactor is inherently safe, becoming subcritical when the temperature rises by more than 10 deg. Cent. In addition there are two independent safety devices which act by inserting sheets of cadmium, and by separating the core by lowering the bottom half.

The reactor was shown complete with control desk which incorporates a system of interlocks designed to prevent faulty operation. Experimental installations include three horizontal channels, and a thermal column of graphite with seven vertical channels which rests on top of the core. Annual consumption of U235 is about 30 micrograms.

In a special exhibition "Electronics in the Organisation" Siemens demonstrated the "2002" computer combined with a wide variety of other equipment into an integrated data processing system. An example is the "Productograph" which serves the purposes of production planning and progress chasing. Diagrammatic indicators present at every instant a synopsis of the machine load and the state of the various orders, while simultaneously counters and recorders book all data required for cost and wages accounting. The large number of data automatically coming in from the machines is supplemented by a few reports transmitted by the operators by pressing push-buttons indicating any interruptions in the normal working together with the cause. Those data collected by the "Productograph" which are to be used for other purposes, e.g. statistics and operations analysis, are transmitted over telex lines to the computer, either directly or by way of an intermediate information store. An example illustrating the application of the "Productograph" was the case of a garage where repairs and service have to be handled for a large number of customers, calling for constant and rapid adaptation in the planning for and labour-saving accounting methods.

The "Telecollecta" system for recording and transmitting to a central point operators' working times utilises an identity card bearing the holder's works number in punched code. This is inserted in the clock when clocking on or off. The reading of the holder's number together with the time are centrally registered on a punched tape which is later employed in the computer to produce a complete wages sheet. This application, which was first shown last year, has now been extended. By supplementing the twelve-digit-reader with a keyboard it is possible to add further information by hand. The card can now function as stock card, allowing the movement into and out of storage of materials, tools, and goods, to be registered in a simple manner.

Important applications of the computer are invoicing and stocktaking. All data are directly accessible in the information store so that the invoice can be made out without the need of preliminary sorting of the orders according to customer or goods code number.

Before each item is invoiced, the computer checks whether it is in stock. If not, the position gets a reference to the probable delivery date. Delivery dates of all positions are individually checked, and for any items currently out of stock a punched card is made out. At the same time, the installation prepares data for the cost account, stock list, and order list, indicating in the last-mentioned case which items require re-ordering or urging. As an aid for the buying department the machine suggests the quantities which should be ordered, taking into account turnover over a given period and other factors.

At longer intervals the stock list, and statistics relating to goods and customers, are printed out in full.

Orders can be placed by means of punched cards or by way of telex or "Selex" connections, the various code numbers involved being fed directly into the computer. The writing out of the invoice and all papers connected with it, such as delivery note, stores chits, &c., can be printed by a single printer or, in the Siemens "Selex" systems, by separate and selectively operating machines which can be situated in different parts of the works, each printing only the document or preparing the punched cards or tapes required in its particular department.

It is also possible to use the system to enquire about articles in stock, by means of a teleprinter which then prints the information which it receives from the computer.

In the semi-conductor field Siemens demonstrated refrigerating elements based upon the Peltier effect (Fig. 10). These components, which measure 40mm by 40mm and are under 10mm thick, consist of a number of Peltier elements each consisting of a combination of a *p*- and an *n*-conductor. The refrigeration capcity is 5W. In vacuum, temperature differences up to 100 deg. Cent. are obtainable. Applications include the cooling of electronic components and biological material, the construction of miniature thermostats or air conditioning plants with a wide temperature range (since by reversing the current cold and hot junctions change places and the refrigerator becomes a heater), and microscope freezing stages where temperatures of −20 deg. Cent. can be obtained in a very small volume.

Among other exhibits were a high-duty silicon transistor capable of switching currents up to 10A and of blocking 400V. This high blocking capacity, however, is achieved at the expense of the gain, which for small current is twenty to thirty but falls to five at the full nominal current. The switching capacity of this *npn*-transistor is 2kW. Losses up to 25W are acceptable with air cooling as in normal use but can be increased with more efficient cooling. The frequency limit is 10 to 20 kc/s.

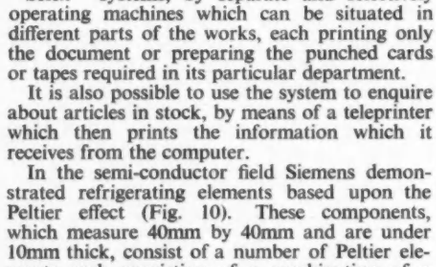


Fig. 10—Peltier refrigerating element, here shown equipped with heat exchanger—Siemens

A sub-synchronous mutator cascade was used to control the speed of a three-phase asynchronous slipring motor. The system is applicable to very large motors which require speed regulation over only a small range, as in the case of fans, compressors or pumps, or for the drives of large bucket wheel excavators, mixers, &c. The speed can be varied rapidly and without the high slip losses and torque changes associated with the use of resistances in series with the rotor windings. The motor delivers its mechanical output through the shaft, its slip output by way of the sliprings to a silicon rectifier. This converts it into direct current which is then converted back into synchronous alternating current by a mercury vapour mutator and returned to the mains with the help of a transformer. By adjusting the reverse voltage of the mutator the speed of the drive can be varied.

In the demonstration the drive had a nominal capacity of 30kW and a 2 : 1 speed range. The load was applied by means of a d.c. generator. The torque could either be constant or vary linearly or with the square of the speed. Sudden loads as well as sudden changes in the required speed could be applied. The controls of the cascade and the load were by means of transidyne circuits.

For endurance tests in the motor car industry of engines, transmissions, and brakes it is desirable to simulate as closely as possible the actual conditions of operation. This can be done with a testbed developed by Siemens on which all quantities which are to be measured, such as torque, revolutions per minute, temperatures, &c., are constantly indicated and recorded. A programme control enables the tests to be run and repeated as often as desired in accordance with a preselected scheme, or as a replica of an actual run on the road. Depending upon the programme carrier, i.e. whether punched tape or magnetic tape, the independent variables may be changed stepwise or continuously. The former may be employed where a digital input and exact reproducibility are important.

In order to enable commercial magnetic tape to be used, an impulse technique was adopted for recording the various quantities. When recording the programme, the speed pulse sequence is taken from a pulse generator directly coupled to the engine crankshaft, and stored on the magnetic tape. During reproduction this sequence is converted by a frequency-voltage transducer and fed into the analogue speed controller. Any static errors are corrected by a superimposed digital control loop.

With punched tape input, the required speed is stored in code in a transistorised information store. In order to allow the same controller to be used, the speed code is converted into a pulse sequence by means of a frequency divider which is then fed into the speed controller. With a reference frequency of 10 kc/s and a required speed value of, say, 4338 r.p.m., the coded number, 4338, caused the frequency divider to give an output of 4338 pulses per second. This corresponds to a long-term accuracy of 0·1 per cent. The torque channel is similarly constructed. In experiments under steady conditions the actual torque value is found from a dynamometer whose pointer is photo-electrically read, the reading being converted by a counting device with a digital value. This again is converted by a frequency divider into a pulse sequence and compared digitally with the required pulse sequence. For recording a dynamical programme on magnetic tape, the torque measurement has to be replaced by that of a suitable related quantity such as the suction in the intake manifold, the carburetter setting, or the torsion in the cardan shaft. The same quantity is then used in the test bed. The programme control is built up from "Simatic" unit elements which facilitate its adaptation to whatever kind of test may be required.

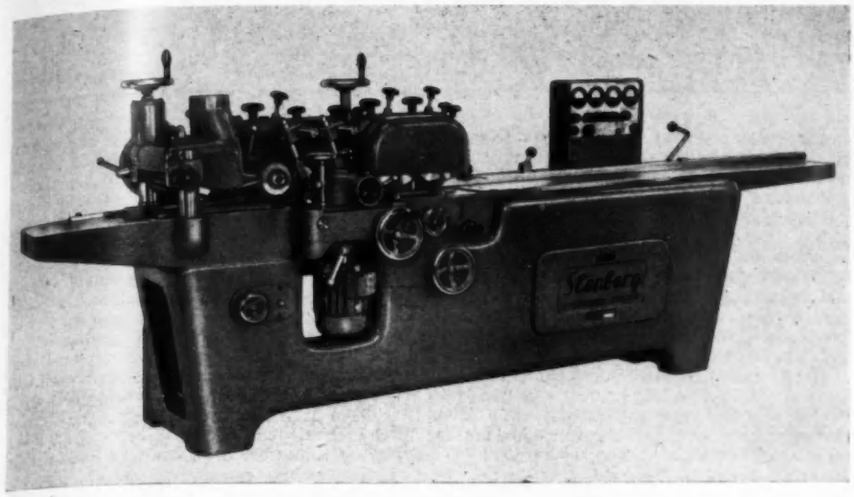


Fig. 11—Four-sided planer-moulder—Stenbergs Maskinbyra

Stenbergs Maskinbyra

A planer and moulder which machines all four sides of the workpiece in one operation was shown by Stenbergs Maskinbyra AB, Stockholm C. Pieces of up to 80mm by 180mm are planed free from skewness without previous thicknessing. The machine which is a combination of an unusually long surface planer with two cutters, and a two-cutter moulding machine, is shown in Fig. 11. It is stated that any normal length up to the longest can be handled, and also very short pieces down to 12in.

Ruhrpumpen G.m.b.H.

In addition to examples of its feed and circulating pumps, both rotary and reciprocating design, Ruhrpumpen G.m.b.H., Witten-Annen, showed equipment for electronically recording the pump characteristic as well as axial and radial forces. The transducers are mostly strain gauges which form part of a Wheatstone bridge and are connected to a two-component recorder. This instrument records the required quantities continuously as functions of the flow.

Gebr. Ritz und Schweizer

Exhibits of Gebr. Ritz und Schweizer, Schwäbisch Gmünd, included a nine-stage centrifugal submersible pump with an output of 15 cubic metres per minute against a head of 245m. The pump which can be used with heads up to 300m, is powered by an 1130 h.p., 3kV, 1475 r.p.m. motor. With inlets at both ends, the rotor is hydraulically balanced in an axial direction. Overall length of this pump which is intended for dewatering a brown coal mine, is 10m and the diameter is 0·7m. Similar submersible pumps are produced for hard coal mines capable of discharging 3 cubic metres per minute against a head of 950m. This allows automatic dewatering, in many cases in a single lift. Such pumps are supplied as explosion-proof designs.

Desgrances & Huot

A liquid level indicator float was shown by Desgranges & Huot S.A., 10, rue Bernard Mazoyer, Aubervilliers (Seine). This is stated to indicate by the appropriate switch position either a high or a low level or to help maintain the level. Completely fluid-tight, it has found application in aircraft fuel tanks ; it can be exposed to any temperature from very low to 450 deg. Cent. and pressures up to 70 atmospheres. The incorporated switch handles currents of up to 8A at 125V and 4A at 220V. The switch is actuated by the float by means of a permanent magnet, accuracy of operation being stated to be of the order of 1mm.

A deadweight abolute manometer (rotating piston design) was also shown allowing precision pressure measurements from 0·05mm Hg (1×10^{-6} lb per square inch) up to 150 lb per square inch.

Premag

A variety of pneumatic impact spanners were shown by Premag G.m.b.H., Geisenheim/Rhein, a subsidiary of Consolidated Pneumatics Inc., New York. One of the most interesting designs was a spanner with incorporated torque presetting stated to achieve an accuracy of ±5 per cent. This power tool which is made in two sizes, for 20–55 mkg and 50–120 mkg respectively, is checked once a day by means of a "Tensimeter." Made by Eduard Wille, Wuppertal-Cronenberg, the latter consists of a calibrated "U" steel shape, the prongs of which are brought nearer together by tightening a test screw. The separation, and hence the force applied by the screw, can be read off a graduated wedge inserted in the gap. The pneumatic tool can be set continuously to any torque within its range which it reaches after about five seconds and then automatically cuts out. Operation is independent of supply pressure fluctuation. The spanners, which weigh 9·5 kg and 13·5 kg, can be switched over to loosening bolts and nuts.

Also shown were automatically controlled, multi-spindle pneumatic spanners for the assembly of internal combustion engines.

A high-duty combined pneumatic percussion drill and hammer shown by the same firm weighs only 3·4 kg. Equipped with carbide-tipped steels of up to 45mm diameter, it can be used equally well foı drilling holes or cutting channels, e.g. for the installation of pipes or cables.

Huttenwerk Salzgitter A.G.

The main field of production of Hüttenwerk Salzgitter A.G., Salzgitter-Watenstedt, is the manufacture of rolled products, in particular sheet, some of which are made into spiral-welded pipes for gas and water mains and oil pipelines. The company exhibited an ultrasonic tester which it uses for the continuous automatic testing of the spiral welds. Readings are indicated on a cathode ray tube and simultaneously recorded. Any flaw in the weld is registered in these two ways, while at the same time the spot is marked on the pipe in colour.

Lucas

For use in air separation plants for high purity nitrogen, tonnage oxygen for steelworks and low flow pilot plants, Lucas Industrial Equipment, Ltd., The Radleys, Marston Green, Birmingham, 33, exhibited an expansion turbine. The device is a radial flow turbine operating at 65,000 r.p.m. (80 to 90,000 r.p.m. are envisaged). At the output end is an air blower fitted with adjustable restriction to act as speed control, so as to operate at optimum efficiency (of the order of 80 per cent). The bearings are gas lubricated with compressed air or gas feed at 60 lb to 70 lb per square inch. The throughput is is 0·319 lb per second or 426 cubic metres per hour, at an inlet pressure and temperature of 5 atmospheres and 120 deg. K., and outlet conditions of 1·25 atmospheres and 85 deg. K.

High rotational speeds are made possible by the gas bearings while contamination is avoided by feeding the bearings with the process gas. In conjunction with oxygen, gas bearings instead of oil-lubricated bearings contribute greatly to safety.

Rheinkalte

A cooling tower with axial flow fan was shown by Rheinkälte G.m.b.H., Düsseldorf, Suitbertusstrasse 137–139. In this model, the entering warm water is distributed by a rotary arm over the filling. Air is drawn in through holes at the bottom of the casing, above the bottom tray, and is drawn upwards by the fan in counterflow to the water. Outer casing tray and fan blades are constructed of glass fibre reinforced polyester. The honeycomb filling consists of phenol-resin reinforced cellulose.

A.E.G.

In the section of its exhibition dealing with the application of digital techniques in industry, Allgemeine Elekticitäts-Gesellschaft, Berlin and Frankfurt/Main, showed numerous models as well as ranges of unit components for building up different kinds of installations.

Digital techniques were illustrated by an electronic drafting machine used in compiling and checking the programme for a large machine tool. Punched tape programme control was used in conjunction with an electronic interpolator, i.e. a computer for calculating successive co-ordinates of a complicated contour from a few given characteristic points. This machine can calculate Cartesian co-ordinates in steps of 0·01mm over a range of 10m in both x- and y-directions. Interpolation between two given points can be linear or circular (given the radius of curvature).

Digital measurement of length was shown with a conveyor on which moved the object which was to be measured. The belt drive was fitted with a photo-electric impulse counter giving one impulse per millimetre travel (if slip is neglected). Beginning and end of the count was fixed by the movement of the object across a photoelectric gate. The result was printed in black or red, depending on whether the measurement lay inside or outside the predicted tolerance. At the same time a sorting gate was operated.

Special attention has been paid to the development of photoelectric units of which examples may be seen in Fig. 12. Functionally, a photoelectric system consists of a light source a receiver, and the amplifier and relay necessary to carry out the desired switching operations. The light source consists of a casing in which are situated a light bulb and an optical system. For the receiver a similar arrangement is used except that the source is replaced by a light-sensitive element which may be a photocell, photodiode, transistor, resistance, or multiplier cell. The five basic classes of installations are axial light sources and receivers, angle sources and receivers, fork gates, reflected light gates, and gates with microscope objective lenses for registering thin pencils of light, such as are used in the case of fine grain materials or scale dimensions. A

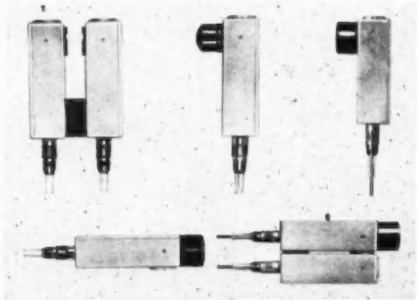


Fig. 12—Photo-electric unit construction elements—A.E.G.

multiplicity of designs is possible owing to the large number of variants of these basic types, but with the A.E.G. unit system these can be built up as required from a comparatively small number of components.

The standard housing permits the use of lenses of different focal lengths and apertures, mirrors and filters on the one hand, and different receiver elements on the other.

The units are built in three size ranges : small

CONTINENTAL AFFAIRS *(continued)*

(20mm by 20mm by 70mm), standard (40mm by 40mm by 130mm) and large (100mm by 100mm by 370mm) which also differ in the maximum distances between light source and receiver which are possible, and which amount to 1m, 5m, and 40m in these three cases. The large units can also be modified to operate with ultra-violet or infra-red light, and can be supplied in extra-robust water-cooled housings for use in steelworks or other heavy industrial plant. With ultra-violet it is possible, for instance, to register the passage of a red-hot billet.

A variety of transistorised amplifiers are available with impulse, ohmic, or relay output.

Large Bore Supercharged Diesel Engine

To satisfy the demand for higher powers required by the trend in ships towards greater deadweight, particularly oil tankers, diesel engines of large bore and high ratings per cylinder have been developed. Among the firms which have utilised their resources for the design and production of a diesel engine of large power has been Fiat Stabilimento Grandi Motori. This company has extended its range of engines to include a new design, the Fiat 900 S., which has a bore of 900mm by 1600mm stroke and is rated to have a normal output of 2100 b.h.p. per cylinder. Units may be built having from six to twelve cylinders to cover a power range from 12,000 to 26,000 b.h.p. The engine is of two-stroke, single-acting design and is supercharged and has been developed from earlier Fiat engines having bores of 750mm and 680mm, all of which are suitable for burning low grade fuels and provide reliability in service at low maintenance cost.

The first of the new large bore engines, a nine-cylinder unit, of which we reproduce a photograph showing the engine on the test bed, ran shop trials at the end of last year and is now being installed in a 38,000-ton deadweight oil tanker under construction at the Navalmeccanica Yard of Castellammare di Stabia in Naples for the Societa Elios of the Lauro fleet group. Of fabricated design the engine embodies mechanical sturdiness and also constructional simplicity due to the adoption of cross scavenging. A diaphragm plate isolates the cylinders from the crankcase and this together with the lower part of the cylinders being completely open to the atmosphere provides an adequate degree of safety against oil contamination and the danger of fire. The design provides for the inclusion of reciprocating scavenge pumps which operate in series with the exhaust-gas-driven turbo-blowers, and this arrangement ensures flexibility of operation at low speeds and also the continued operation of the engine should trouble develop with the turbo-blowers.

This design of engine is subjected to moderate thermal and mechanical loading and the Mark 909 S. unit has been exhaustively shop tested burning heavy fuel, and the following are the main results obtained during shop trials :

	Normal Rating	Overload
Output, b.h.p.	19,043	26,100
Revolutions per minute	122·7	131·4
M.E.P., Kg./cm²	7·62	9·76
Specific fuel consumption, grammes/h.p./hour	154	165·5
Mean temperature at cylinder exhaust, deg. Cent.	298	343

At the overload output of 26,100 b.h.p. the exhaust was quite clear and this output represents 2900 b.h.p. per cylinder. Since these trials a two-cylinder experimental unit has achieved an output of over 3000 b.h.p. per cylinder with a brake mean effective pressure of 11kg per square centimetre.

Euratom Developments

According to Monsieur de Groote, a Member of the Euratom Commission, the point at which large-scale investment in nuclear power stations in certain parts of the Community will become an economic proposition may come in 1965. If present forecasts prove correct nuclear power will capture half of the new energy market between 1965 and 1970, and two-thirds between 1970 and 1980. Even if the "breakthrough" is delayed until 1970, the nuclear power capacity required by 1980 will still be some 25,000MW, and it may well be as much as 40,000MW.

Euratom is helping to hasten the "breakthrough" by forecasting energy needs ; financial, technical and other forms of material aid ; laying down standard health and safety legislation, and the pooling of documentation and information. Probably its main contribution is in the field of research. With 215 million dollars available for the five-year period 1958–63, the Community is initiating work in its own joint research centres ; concluding contracts of association for specific joint projects by Euratom and other institutions ; negotiating research contracts with specialised institutes and industrial firms for work on Euratom projects ; giving assistance to projects initiated by other bodies ; and taking part in research projects under bilateral or international agreements with third countries.

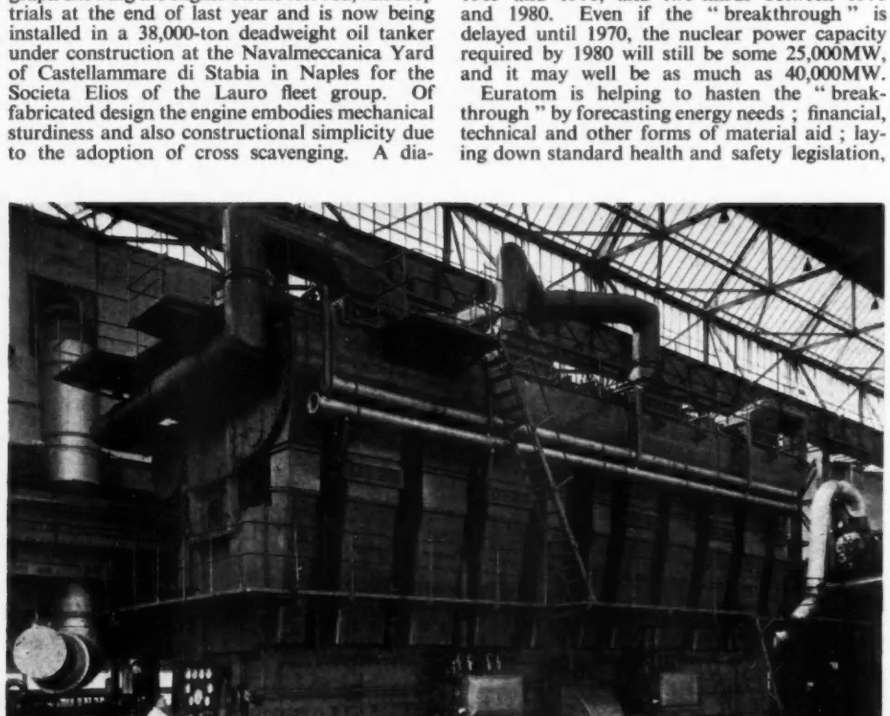
Three distinct classes of reactor are therefore being developed.

First come reactors already in industrial use. These are the graphite-moderated, gas-cooled systems developed in the U.K. and France ; the pressurised and boiling-water systems developed in the U.S.A. and the organic moderated type.

Secondly, designs not yet proved but with good prospects of being used for power production. Here research is centred on the development of moderators, coolants and fuel elements, the aim being to gather data for a prototype industrial reactor. In this category is the ORGEL programme for a heavy-water moderated, organic liquid-cooled reactor, on which the main work at Ispra will be concentrated.

Thirdly, advanced reactors, in which the technology is much less certain, but where there is potential development. The O.E.E.C. high-temperature, gas-cooled "Dragon" project at Winfrith Heath (Dorset) is in this category ; another advanced gas-cooled reactor is also being developed in France. In both cases the aim is operation at higher temperatures.

At the same time the Community is also looking further ahead, and contributing to research in more fundamental problems. Of these one of the most important is fusion. In March, for instance, a third contract was signed by the Community for work in this field. This was with the Plasma Physics Institute—whose principal associate is the Max-Plank-Gesellschaft—at Garching, near Munich. The contract will cover an initial period of three years. The total cost of the project is estimated at DM30,000,000.



Mark 909S Fiat engine on the test bed

Halden Reactor

Experimental operation with the first fuel charge for the Halden boiling heavy-water reactor was terminated on April 29, with all planned experiments successfully completed.

The reactor went critical on June 29, 1959, and produced steam for the first time on October 5, 1960. The experimental programme in Halden has been carried through in two stages. The first step involved operation at powers of only a few watts with the object of establishing experimentally the basic reactor data. It has since been operated at powers of up to 6000kW with temperatures up to 155 deg. Cent., corresponding to the designed operating conditions for the first fuel charge. The reactor will now be modified to accommodate the second fuel charge, increase output and expand experimental facilities. When the second fuel charge has been installed, the reactor will be brought up to 20,000kW and 230 deg. Cent. early in 1962.

Locking Device for Push-Button Controls

Provision for blocking push buttons of electrical installations by means of a device which can be locked in position was developed a few years ago by Asea, of Västerås, Sweden. This idea has now been extended to cover a case which frequently arises in maintenance work, viz. that more than one person requires to lock the same push button in the depressed position. Accordingly, the new device can be locked independently with up to four padlocks and the push button cannot be released until all the locks have been removed.

THE AMERICAN SCENE

By Our American Editor

An American in Space

WITH considerable fanfare, the United States took their first small step on May 5 toward manned exploration of space. When Commander Alan B. Shepard, Jr., left Launch Pad 5 atop a " Redstone " missile, he was blazing a trail for American " astronauts " to follow—a trail that will lead to the moon and the planets. Behind him he left Government officials, members of Congress, scientists and a public at large still uncertain and debating over the objectives, value and urgency of man's exploring space. In comparison with the around-the-world space flight by Soviet " cosmonaut " Yuri A. Gagarin on April 12, the fifteen-minute flight by " astronaut " Shepard some 115 miles into space and 290 miles downrange from the launching pad was obviously a modest and belated jump into space. His launching rocket had only one-tenth the power of the Soviet missile, and his capsule was one-fifth as heavy. The flight was only one-sixth as long in time and about one-ninetieth in distance.

With the publicity build-up kindled by the American Government, Press, radio and television and the openness with which the launching was conducted, the manned " Mercury " flight tends to become magnified beyond its intrinsic importance. Perhaps inevitably, it was cast as America's answer to the Soviet feat, which it was not. Ironically, the enthusiastic public reaction to the Shepard flight tends to support the argument made by Wernher von Braun some three years ago, proposing that at times it is important to conduct space flights for primarily psychological and prestige reasons. It is an argument which thus far has found no favour within the National Aeronautics and Space Administration, which tends to emphasise strictly scientific and technical objectives for a space programme. Psychologically, it is obvious that no American space shot thus far has so captured and fired the public imagination as did the fifteen-minute flight of Commander Shepard. Symbolised on Launch Pad 5 was all the drama, heroism and uncertainty of exploration such as never can be conveyed by a scientific satellite sitting atop a missile. There was the drama of a young man staking his life against the workings of a complex machine, of personal heroism and courage in being rocketed out into space, of a gripping tension as a man sits alone for nearly three hours in a capsule waiting for a rocket, fuming with highly explosive fuels, to be fired, and then finally the feeling of relief and elation when the slim rocket soars straight up into space and the man some fifteen minutes later returns to earth. From a scientific and technological standpoint what was the significance of this first " Mercury " flight?

Scientifically, it proved little more than what was known from Major Gagarin's flight and flights of the United States X-15 rocket aircraft about man's ability to survive and function under the weightless conditions of space. In fact, when a flight similar to the present one was proposed by von Braun in 1958, it was dismissed by some of the present officials of the National Aeronautics and Space Administration as little more than a publicity stunt. The only basic difference from the original von Braun proposal is that the " Redstone " flight was conducted with a meticulously designed space capsule specifically designed for orbital missions. What then was the significance of the first Mercury flight? In an international context its unintended significance was to provide a further demonstration that the United States, handicapped by its lack of rocket power, was several years behind the Soviet Union. Quite naturally, American officials would prefer not to think of man-in-space as a race. But in historical perspective it seems evident that there is to-day as much of an international race for the new frontiers of space as there was four centuries ago to explore the New World. To American officials, the basic significance of the " Mercury " flight was that the United States had at least taken the first step toward manned exploration and military exploitation of space. In the next few months they will attempt to put an unmanned " Mercury " capsule into orbit around the earth, then try to fly the capsule in orbit with a monkey. And, hopefully, by the end of this year, one of the seven " Mercury " " astronauts " will ride in the capsule around the earth, first for three orbits and later for as many as eighteen. Technical details of the current American man-in-space programmes appeared in the April 21, 1961, issue of THE ENGINEER, pages 645 to 649. Following the " Mercury " flights will come the more advanced programme known as " Project Apollo." The " Apollo " capsule will carry three men for much longer periods in space. Initially, the plan is to place a manned " Apollo " vehicle in orbit around the earth for a week perhaps by 1966. Then as more powerful launching rockets, such as the "Saturn," become available, the " Apollo " capsule will be used, perhaps by 1969, for a manned trip around the moon and back.

The objective of the man-in-space programme, started in 1958 with Project " Mercury," is the manned exploration of the moon and planets such as Mars and Venus. It is an objective, however, which is yet to be enthusiastically endorsed within the Government and the scientific community or to be specifically defined in terms of time, cost and urgency. There is general agreement that ultimately man can and must go into space as a scientific observer and explorer of the vast stretches and bodies in the solar system. With his brain, which is still one of the best judgment computers ever designed, man can perform tasks in space which instruments never can. The preliminary exploration will be made by instruments, but ultimately it must be man who will make the detailed examination. Furthermore, it is becoming obvious that if the historic pattern is to be followed as space frontiers are pushed back, man may have to be ready with military missions in space, such as reconnaisance, repair of military satellites, observation and destruction of unfriendly military satellites. Because of the costs, risks, and uncertainties involved, however, there is no agreement among scientists, military officers and Government officials about how quickly the complex, costly ladder into space should be erected.

The objective and the urgency of the man-in-space programme have gone undefined in both the Eisenhower and Kennedy Administrations. In his final budget message, former President Dwight D. Eisenhower proposed that the construction of the " Apollo " capsule be postponed until the danger, cost and desirability of manned exploration of space could be more clearly assessed. President Kennedy, in effect, endorsed this decision by declining to request additional funds for the " Apollo " project. The initiative for spurring the space exploration effort is coming at this point not from the President but from Congress, where the House Space Committee just added 126,600,000 dollars to the Administration's space budget, with the bulk of the new funds going to the " Apollo " project. The continuing debate and the indecision over the future of man-in-space programmes spring partly from the enormous cost involved. One review conducted last year by the President's Science Advisory Committee showed that the cost of landing a manned expedition on the moon could run as high as 40,000 million dollars. Confronted with such costs, some influential scientists within the Government raise the question whether the money could not be more profitably spent on improving education or in other fields of scientific research. Combined with these cost factors, objections have been raised, particularly by the older scientists who still have an influential advisory part in Government, about the safety and scientific necessity of sending man to explore interplanetary space. They argue that at least for the foreseeable future far more information can be obtained about space, the moon and planets—and at far less cost—by sending instrumented vehicles rather than men. It also is argued that there is no assurance that once man ventures deep into space and beyond the protective blanket of the earth's magnetic field he can be safely shielded against the intense radiation emanating from the sun during solar storms.

Probably the best answer to these objections came in a recent report issued by the Space Science Board of the National Academy of Sciences. The board, composed of eighteen prominent scientists, conceded that " it is not likely that man can contribute much if anything to knowledge by simply orbiting about the earth or mere travel through interplanetary space." It is " most probable," the report said, " that instruments can do all that is necessary " with payloads

THE AMERICAN SCENE *(Continued)*

that would be much lighter and cheaper than manned capsules. Nevertheless, the report continued, " man in orbit is worth pursuing " for the reason that " the ultimate exploration of the moon and planets will be done by man. This means that experience must be gained, step by step, and the orbiting of man is the first of this long sequence of steps." In the wake of Commander Shepard's flight and the more ambitious one by Major Gagarin, the policy questions confronting the Administration, Congress and the American public are : How fast can and should the United States climb these rungs into space and how much is it willing to pay for this admittedly expensive, difficult and yet most daring venture in man's search of the unknown? Ultimately, in view of the costs and hazards involved, the question may arise for both the United States and the Soviet Union of whether it would not be more logical to make the exploration of space an international effort—as proposed in broad terms by Presidents Eisenhower and Kennedy.

Yankee Atomic Power Station in Massachusetts

No. II—(*Continued from page* 802, *May* 12, 1961)

The Yankee nuclear power station of the Yankee Atomic Electric Company at Rowe, Massachusetts, commenced electric power generation on November 10, 1960, *and is scheduled to be in full commercial operation by July* 1. *The station will have an ultimate thermal output of* 485*MW and an ultimate net electrical capacity of* 136*MW. It was built by the Westinghouse Electric Corporation at a cost of about* 40,000,000 *dollars and employs the firm's pressurised light-water reactor. The reactor core comprises some* 25 *tons of* 3·4 *per cent enriched* UO_2 *pellets in stainless steel tubes. It is expected that the new station will eventually provide power at a cost of* 0·9 *cents per kilowatt-hour.*

THE joint between the vessel and closure head is designed to utilise either gaskets or seal welds to effect leak tightness ; connections are provided to monitor any leakage past either gasket. The gaskets are self-energising, stainless steel O-rings plated with silver to provide good seating. The vessel will be operated initially with gaskets in order to obtain running experience. If leakage proves to be low, no seal welding will be employed.

The closure head is attached to the vessel with fifty-two 5¼in studs. These studs contain a central axial hole suitable for heaters and extend through the closure nut for applying stud tensioners as an alternative. A reduced-diameter closure joint was selected to cut down the weight and cost of the vessel and closure head. This choice improved vessel flange design and reduced the required bolting force, but it followed that the thermal shield must be fabricated in segments. These segments are bolted together inside the vessel. The weight of the reactor vessel is transmitted through twenty-eight support lugs to a ring girder which is an integral part of the neutron shield tank. The ring girder rests on the concrete primary shield surrounding the vessel and neutron shield tank. Each support lug rests on a fitted, radial pin for accurate location of the vertical centreline of the vessel. The pins permit radial expansion of the vessel while maintaining fixed centreline and levelness.

In order to obtain insurance on the plant, it was necessary to design, fabricate and test the reactor vessel in accordance with the A.S.M.E. Boiler and Pressure Vessel Code, Section VIII. Although the reactor vessel is designed for a maximum system pressure of 2500 lb per square inch absolute, it operates at a nominal system pressure of 2000 lb per square inch absolute. The margin between nominal operating pressure and design pressure allows for system pressure transients and safety and relief valve settings. The vessel and head are exposed to inlet coolant temperature, which should be no higher than 513·5 deg. Fah., but additional margin for temperature transients is provided, as the design temperature is 650 deg. Fah.

Only materials permitted by the A.S.M.E. Code were used to fabricate the vessel. The internal surfaces of the vessel are clad with austenitic stainless steel ; the base material is carbon steel. The cylindrical section of the vessel is 7⅞in thick with 0·109in cladding ; the hemispherical bottom head is 3⅞in thick with 0·109in cladding, and the closure head is 7in thick with 0·109in cladding. The internal height of the vessel is 31ft 6in with an inside diameter of 9ft 1in. The inside diameter of the primary coolant nozzles is 19⅛in.

The only operational limits imposed on the vessel, other than maximum operating pressure and temperature, concern heating and cooling rates and minimum hydrostatic test temperature. If the vessel is heated from an ambient temperature of 70 deg. Fah. the maximum rate of heating must not exceed 50 deg. Fah. per hour up to a temperature of 250 deg. Fah. From a temperature of 250 deg. Fah. up to operating temperature the maximum rate of heating must not exceed 150 deg. Fah. per hour. The maximum permissible step increase in coolant temperature is 40 deg. Fah., when the vessel is in an isothermal condition. The vessel may be cooled at a maximum rate of 150 deg. Fah. per hour down to a temperature of 150 deg. Fah. ; however, there may be some leakage past the gaskets when a rate of 50 deg. Fah. per hour is exceeded. The vessel cannot be subjected to a hydrostatic test unless the metal temperature is at least 90 deg. Fah. This limit was set by adding an adequate safety margin to the temperature at which the vessel material possessed a Charpy V-notch impact energy absorption of 30ft/lb.

A neutron shield tank around and under the reactor vessel contains a 36in thickness of water. Pie-shaped canned " Masonite " shield blocks cover the gap between the core vessel and shield tank at the top of the vessel so as to attenuate neutrons streaming upward between the vessel and tank. Beyond this shield tank there is a reactor or " primary " shield made of reinforced concrete that is 5ft 6in thick up to the vessel flange height, and 4ft 6in above. The concrete

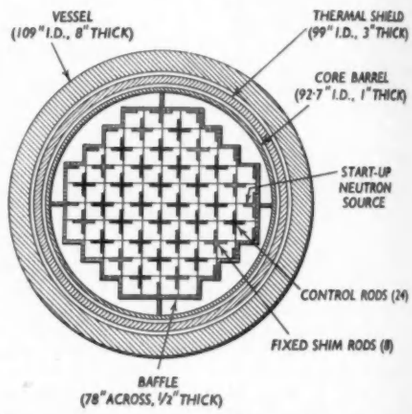

VESSEL (109" I.D., 8" THICK)
THERMAL SHIELD (99" I.D., 3" THICK)
CORE BARREL (92·7" I.D., 1" THICK)
START-UP NEUTRON SOURCE
CONTROL RODS (24)
FIXED SHIM RODS (8)
BAFFLE (78" ACROSS, ½" THICK)

Fig. 8—Cross section of initial reactor core with seventy-six fuel assemblies, twenty-four control rods and eight fixed shim rods

" secondary " shield, which surrounds the entire reactor system within the vapour container, is 5ft 6in thick up to the charging floor, and 2ft above.

First Reactor Core

The initial core approximates in shape a right circular cylinder 75·4in in diameter and 91·86in high, giving a length-to-diameter ratio of 1·2. The core consists of seventy-six vertical fuel assemblies, twenty-four control rods and eight fixed shim rods. The fuel assemblies are essentially square in cross-section and are placed in a close-packed square lattice. The seventy-six individual, replaceable fuel assemblies are held in the core between the lower and the upper core support plates. Holes are provided in both support plates for the handling sockets which position the fuel assemblies and act as coolant inlets and discharge nozzles. These support plates are also provided with thirty-two cross-shaped slots to allow passage of the twenty-four cruciform control rods and the eight cruciform

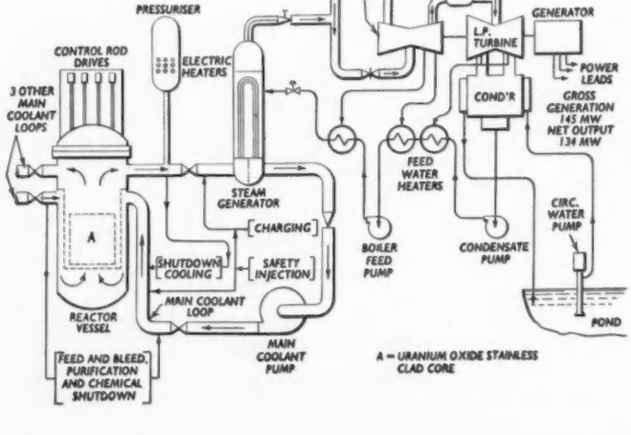


Fig. 7—Simplified flow diagram of the primary and secondary reactor systems

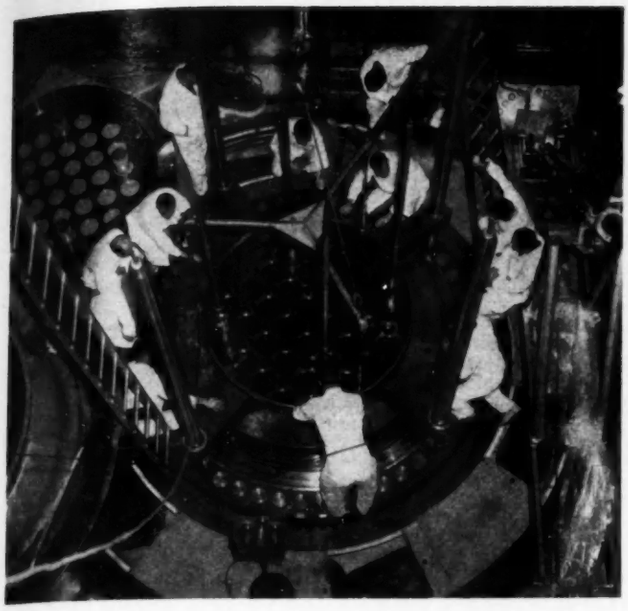


Fig. 9—Placing of guide tube support plate into the reactor vessel

Fig. 10—Placing of core barrel assembly into the reactor vessel

fixed shim rods. The axis of the control rods is parallel to the vertical axis of the core and each control rod is actuated by a separate mechanism above the core. For refuelling purposes the control rod drive mechanisms are disengaged from the control rod drive shafts, leaving the rods completely inserted in the core. After removal of the reactor vessel head, on which the drive mechanisms are mounted, and the reactor internals above the core, the fuel assemblies and control rods can be removed individually.

The reactor core is surrounded by a form-fitting baffle which confines the coolant flow within the fuel bearing zone. Outside the baffle the core barrel extends downward from the upper support plate, carrying the lower core support plate and the weight of the core. Coolant water between the form-fitting baffle and the support barrel acts as a neutron reflector to the core. The core construction is of the open lattice type which permits flow redistribution throughout the core and ensures that, even under the most unfavourable conditions which can be reasonably postulated, coolant reaches all portions of the core. The core is designed to operate with sub-cooled boiling during normal operation, and the attendant density variations cause small radial components of velocity.

Fuel Elements

The basic fuel assembly for the first core measuring 7·61in square and 111·25in overall is composed of 0·340in o.d. stainless steel tubes which contain uranium dioxide in the form of ceramic pellets 0·294in in diameter and 0·6in long. The required dimensional tolerances on diameter for the individual pellet are obtained by centreless grinding after sintering. The fuel tubes are A.I.S.I. Type 348 stainless steel with a wall thickness of 0·021in. Collapse tests have indicated that the strength of Type 348 is superior to other stainless steels in this application and that the can will withstand anticipated operating conditions without collapse. The fuel pellets are placed in the tubes in groups of twenty-five. Each group is separated from the next by a perforated stainless steel disc coated with braze material. Each disc has a circumferential groove into which the tube is crimped during the loading process, fixing its position until the entire sub-assembly is brazed. The discs are spaced so that each group of twenty-five pellets is allowed a free expansion space. The discs are provided in order to prevent progressive distortion of the fuel which might be caused by repeated differential expansion between an uninterrupted fuel column 90in long and the surrounding stainless steel tube ; such differential expansion would occur with every change in reactor power level. Stainless steel end plugs are welded into the ends of each tube. The welding is of the tungsten inert gas shielded arc type and has shown a high degree of integrity.

The fuel rods are assembled on a square lattice with a normal centre-to-centre pitch of 0·422in and on an odd pitch of 0·454in for those rows of tubes in line with the control rod vanes. Two fuel assembly designs are used which contain 304 and 305 fuel rods respectively ; each is basically an eighteen by eighteen rod square. Rods are omitted from this pattern as required to provide slots for the passage of the vanes of the cruciform control rods, thereby reducing the number of rods from 324, the number in the full eighteen by eighteen complement, to 304 and 305. The total number of rods which form the seventy-six fuel assemblies is 23,142.

The fuel rods are assembled into fuel element sub-assemblies by brazing tubular spacers at 8in intervals to provide proper spacing between rods and to furnish the required structural rigidity. Thus the structural support for the fuel assembly is in the fuel tubes themselves. The fuel assembly consists of eight sub-assemblies which are free to float axially about a ninth centre sub-assembly attached securely by means of machine screws to the end plates. The eight outer sub-assemblies are guided at each end by end plugs which engage a hole in a slip-fit arrangement in the end plates. All sub-assemblies are tied together at a number of points along their length by means of tie straps, forming a complete fuel assembly that functions as an integral unit. Rubbing straps brazed to the outer tube row of each of the outer eight sub-assemblies at four axial positions prevent undesirable rubbing of a control rod on a row of fuel tubes, and eliminate fuel rod surface contact between adjacent assemblies.

The fuel assembly is specifically designed to prevent excessive thermal bowing. Under the worst conditions of bowing caused by thermal gradients, allowing for the worst combination of mechanical tolerances, it has been calculated that there is adequate clearance between fuel assembly and adjacent control rod. Theoretical results were based upon linear and non-linear distribution across the fuel assembly and agree to within 5 per cent. with various full-scale experimental tests conducted on sub-assemblies.

Control and Shim Rods

The reactor control rods are cruciform in shape, twenty-four in number, and are fabricated from a silver-indium-cadmium alloy. This alloy has a relatively high neutron absorption cross-section, is essentially "black" to thermal neutrons, and has a wealth of resonance structure to enhance its worth. The alloy has approximately the same worth as hafnium and is available at a lower cost. As the corrosion resistance of the alloy is marginal, even under the normal low oxygen conditions in the Yankee reactor, the control rods were plated with nickel to a nominal thickness of 0·0005in. Heat treatment followed plating to give a diffusion bond between the Ni and Ag-In-Cd and to increase the creep strength.

A "Zircaloy-2" follower, connected to the active portion of the control rod, acts as a guide and prevents the formation of a water slot in the core when the control rod is withdrawn. The follower also prevents excessive by-pass coolant flow through the control rod channel. The joint made between the absorber section and the follower has been designed to allow maximum handling flexibility in that a single handling tool is used to handle either the absorber or the follower. In addition, since the joint can be broken, less head room is needed during handling operations. In the reactor core, the types of fuel assemblies are limited to two. This simplifies the fabrication process and loading of the core, and results in a core having thirty-two cruciform slots of which only twenty-four are occupied by movable control rods. The remaining eight cruciform slots are filled by fixed shim rods consisting of a boron stainless steel section and a "Zircaloy-2" section. Each end of the rod is mechanically identical with the other, so that the rod may be inverted and either section may be used as material in the core, as required for proper reactivity and flux distribution.

Core Structure

The reactor core structure consists, in general, of an upper and lower core support plate, an upper and lower core support barrel, a core barrel and a baffle structure. The major functions of the core structure are to : (1) support the weight and maintain the orientation of the fuel assemblies ; (2) support and secure the position of the control rod shroud tubes ; (3) absorb the impact of the control rods on the upper core support plate during a scram ; and (4) maintain control rod orientation. Each core support plate is a rigid assembly of two perforated plates. The upper and lower plates of each support plate are 1·25in and 1·625in thick, respectively. The plates are joined by seventy-six sleeves welded directly to the plates, which position the fuel assembly handling sockets. The sleeves, together with a spacer ring on the outer edge of the plates, stiffen the two plates and form a rigid sandwich support structure. In addition to supporting the fuel assemblies, the support plates position the control rods by means of guide blocks bolted and dowelled to the support plates. The control rod shrouds are positioned by bolts to the lower core support plates. Dashpot stops are bolted securely to the upper face of the upper core support plate.

The baffle structure separates the incoming cooling water flowing downward outside of the core from that flowing upward through the core.

THE AMERICAN SCENE *(continued)*

Reinforcing ribs, running axially at strategic positions along the baffle walls, strengthen the structure to withstand the hydraulic pressure differential. As a secondary function, the baffle structure, of 0·5in thickness, acts as an effective attenuator for gamma rays from the core. The core barrel is fabricated from 1in plate and is situated between the baffle structure and the thermal shield. The lower core support plate is dowelled and bolted to the lower rim of this barrel. The upper rim of the core barrel and the upper flange of the baffle are dowelled and bolted to the lower flange of the lower core support barrel. The upper flange of the lower core support barrel is supported on a circumferential ledge machined in the pressure vessel wall at the level of the reactor vessel flange. The upper core support plate is dowelled and bolted to the lower rim of the upper core support barrel. The top flange of the upper core support rests upon the upper flange of the lower core support barrel. The guide tube support plate is supported and positioned by the upper flange of the upper core support barrel and, in turn, supports the guide tube hold-down plate and ring.

The entire core support structure rests as an integral unit on the support ledge of the vessel

Fig. 11—Fuel element assembly comprising stainless steel tubes containing uranium dioxide pellets

and is retained by a compression load that is applied to the core hold-down ring by the vessel head. The core hold-down ring acts as a large Belleville spring with an induced compression load designed to have a greater force than that which results from the pressure differential across the core. Four guide pins orient the lower core support barrel with respect to the vessel, and four additional guide pins orient the remaining components which rest upon the upper flange of the lower core support barrel.

The neutron source consists of both polonium-beryllium sources and regenerative antimony-beryllium sources. The polonium-beryllium sources are of sufficient strength for the initial loading, start-up, and testing of the reactor. The antimony-beryllium sources will become activated during operation of the reactor as the polonium-beryllium sources decay. All sources are contained in stainless steel tubes mounted on four vertical vanes each extending a few inches into a different quadrant of the core.

Control Rod Drives

Each of the twenty-four reactor control rods is driven by its own positive-grip mechanism mounted on the vessel head. These mechanisms are all identical, and fulfil the functions of regulation, shim and safety for each rod. The design of the mechanisms is based upon the magnetic jack principle which provides the advantage of hermetic closure for the primary system. This concept was chosen because of the high pressure and stringent leakage requirements which limit the use of mechanisms having shaft seals or packing. Any mechanically sealed penetration of the reactor head is undesirable, not only from the leakage standpoint, but also because of the differential pressure forces tending to eject the seal shaft or rod from the reactor. As the Yankee mechanisms were restricted to a hermetically sealed design, the only mechanisms which appeared practical were the canned motor-roller nut and the relatively newer magnetic jack. The 400 lb weight of rods indicated that wear might limit the life expectancy of canned roller nut type mechanisms, and, therefore, development of a magnetic jack was undertaken.

The motion of the rod is accomplished by the sequential engagement of two latch assemblies. Force is applied to the latches by means of magnetic flux driven through the pressure shell from five solenoid coils surrounding the shell. The coil action is programmed so that the stationary and movable grippers alternately engage the grooved drive shaft ; the stationary gripper holds the shaft while the movable gripper goes to a new location so as to raise or lower the control rod through each $\frac{3}{4}$in step. The movable and stationary grippers are positioned so the latches engage and disengage the drive-shaft grooves without load. Repetition of the basic $\frac{3}{4}$in lift cycle, at frequencies up to 40 steps per minute in either direction, allows the rod to be moved at an average rate of 15in per minute maximum. Power is supplied to the mechanism by a series of cam-operated switches which actuate magnetic contactors feeding direct current pulses to the coils to produce the steps required. Prototype life tests under simulated reactor conditions have demonstrated successful operation with only nominal wear through the design life of 2000 excursions. This is equivalent to about one million individual steps of $\frac{3}{4}$in.

Two distinct advantages are inherent in the step motion of this mechanism. No torque is applied to the control rod to cause wear, and the digital nature of the cycle precludes any possible overspeed during rod withdrawal despite errors in the command signal, because the coil inductances limit the maximum cycling rate. Wear of latch arms and drive shaft teeth has been virtually eliminated by the load transfer feature of the design. The control of side thrust forces on magnet armatures through accurate centring, and the introduction of fixed radial flux gaps has also largely eliminated wear on the chromium-plated sliding surfaces which guide these armatures.

Reliable scram is assured by a conservative selection of tooth and linkage geometry in the latch assemblies. The geometry allows scram to occur at friction coefficients as high as 1·55. Hot tests have indicated that scram motion of the drive shaft begins within 0·15 sec. of power interruption to the mechanism latch coil. Furthermore, a spring is provided at each latch magnet armature to ensure quick return of the latch mechanism during normal cycling, but these springs produce only 30 lb force and are not required for scram. The mechanism drive shaft assembly is completely independent of the mechanism when all coils are de-energised. This allows easy removal of the complete reactor vessel head and mechanisms during refuelling. Each control rod drive shaft attaches to one of the cruciform shaped control rods by means of a latch. An unlocking rod allows the control rod to be disconnected from the drive shaft by means of a remote handling tool which grasps the upper-most end of the shaft. Each drive shaft assembly carries a piston and cylinder hydraulic shock absorber to limit the decelerating forces on the control rod and core plate structure caused by scramming.

(To be continued)

Discovery of New Element at Lawrence Radiation Laboratory

The discovery of an isotope of element-103 was announced on April 12 by a team of scientists at the Lawrence Radiation Laboratory, which is operated for the U.S. Atomic Energy Commission by the University of California at Berkeley. The scientists have suggested the name Lawrencium (chemical symbol Lw), for the new element in honour of the late Professor Ernest O. Lawrence, Nobel prize winner, inventor of the cyclotron and founder of the Laboratory which now bears his name.

The discovery was made by nuclear chemists Albert Ghiorso, Torbjorn Sikkeland, Almon E. Larsh and Robert M. Latimer of the Lawrence Radiation Laboratory. They performed their experiments with the heavy ion linear accelerator (" HILAC "), one of the major tools of nuclear research at the Lawrence Laboratory. First evidence for the creation of the element-103 isotope was achieved on February 14, 1961. The following two months were spent in confirming the February results. The element-103 isotope is the first to be discovered solely by nuclear methods. No chemical techniques were used in its identification.

The new element was created by bombarding a target consisting of three-millionths of a gramme of Californium (element-98) with boron 10 or boron 11 nuclei having energies of about 70 MeV. The scientists deposited Californium over an area $\frac{1}{10}$in in diameter on a nickel foil having a thickness of 0·00005in. This target fuel was enclosed in a container filled with helium and placed in front of the highly concentrated beam of " HILAC."

When a Californium atom captured a beam nucleus, a new nucleus was instantaneously formed, several neutrons came off and the resulting nucleus flew out of the target. This nucleus was slowed down by colliding with helium atoms and was attracted to a thin copper conveyor belt. The belt was periodically pulled a short distance to place the collected atoms of element-103 in front of a series of silicon crystal detectors. The silicon detectors recorded a maximum of five events per hour in which alpha particles of 8·6 MeV were emitted by atoms of element-103. No attempt was made to identify the resulting daughter atoms of Mendelevium (element-101). Final proof of the presence of element-103 was obtained through a series of experiments which ruled out the possibility that isotopes of element-102 or element-101 might have produced the 8·6 MeV alpha particles. The half-life of the 103-isotope was determined to be about eight seconds.

The new 103-isotope is thought by scientists to have a maximum atomic weight of 257, although further research will be required before this can be established conclusively. The actinide concept, elucidated by Dr. Glenn T. Seaborg, the former University of California nuclear scientist and new Chairman of the U.S. Atomic Energy Commission, indicates that element-103 should be the last of the actinides to be discovered. The actinide series consists of fifteen elements with atomic numbers 89 to 103, all of which have similar properties. Element-104 should have chemical properties different from those of all the preceding trans-uranium elements. According to one scientific theory, element-103 is a " dinosaur " of matter, which was formed at the birth of the universe, but decayed out of existence in a matter of weeks following creation.

The discovery of element-103 shows no promise of direct practical application, but will broaden man's fundamental understanding of matter and its properties. Since 1940, scientists at the University of California have discovered or participated in the discovery of ten synthetic elements heavier than uranium—from neptunium, element-93, to element-102, the discovery of which was reported in 1958. The list includes the important atomic energy fuel, plutonium, element-94.

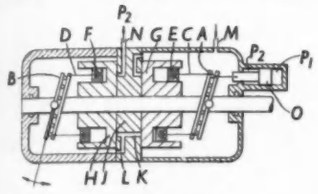
BRITISH PATENT SPECIFICATIONS

The dates printed are those of application and publication on completion. Copies of specifications may be obtained at the Patent Office Sales Branch, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each

PUMPS

865,648. January 1, 1960.—MULTI-STAGE VARIABLE CAPACITY RECIPROCATING PUMPS, Boulton Paul Aircraft, Ltd., Pendeford Lane, Codsall, near Wolverhampton. (*Inventor : John Dudley North.*)

This invention relates particularly to rotary radial-cylinder pumps and swash-plate pumps. It provides a variable-capacity pump comprising two or more stages and means for comparing the output pressure of each stage with the output pressure of the preceding stage to control the delivery of the preceding stage so that the total rise in pressure effected by the pump is shared by the stages in ratios determined by the comparing means. Preferably the arrangement is such that the interstage pressure differences are equal, irrespective of the actual delivery of the last stage. Referring first to the



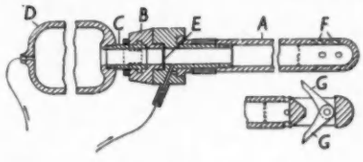
No. 865,648

drawing the drive shaft carries two swash-plates *A* and *B* pivoted to the shaft and connected by push-rods *C* and *D* respectively to pistons *E* and *F* respectively, reciprocating in cylinders in the first stage cylinder block *G* and second stage cylinder block *H* respectively. The two stages are separated by the stationary partition *J* in a fluid-tight manner except for a conduit *K* whereby the delivery from the first stage block *G* is delivered to the inlet of the second stage block, the interior of the second stage of the pump being pressurised to a value P_1 through the branch conduit *L*. The interior of the first stage is pressurised to a value L1 by the fluid entering the inlet *M*. The stroke of the pistons of the final or second stage, as determined by the inclination of the swash-plate *B*, is controlled in any convenient manner, to provide a desired final delivery from the outlet *N*. The inclination of the swash-plate *A* controlling the reciprocation of the pistons *E* of the first stage is determined by a differential area piston O of which the larger face is subjected to the delivery pressure P_1 from the first stage whereas the smaller area is subjected to the outlet pressure P_2 of the second stage. The differential piston areas are in the ratio 2:1 so that the swash-plate *A* will be held inclined at an angle such as to maintain a delivery from the first stage equal to the output from the second stage plus any leakage from the second stage casing to the first stage casing. This ensures that the intitial pressure of the second stage is equal to the output pressure of the first stage and that the initial pressure of the second stage is doubled by virtue of the 2:1 ratio of the differential piston *O*. Thus the two stages share equally in the pressurising of the fluid from pressure L1 to pressure P_2 and that such equality is maintained irrespective of the actual delivery and pressure from the last stage. Single swash-plate pumps are usually capable of working with pressure up to 3000 lb per square inch pressure rise, so that two of them in series are capable of an output pressure of up to 6000 lb per square inch plus the initial pressure L1 in the first stage. This initial pressure is usually only a few pound per square inch and thus introduces an insignificant correction to the pressure balance in the control cylinder except where the total pressure rise is so small that considerable difference in the pressure rise between individual pumps is immaterial. It is to be noted that the high-pressure pump casing does not required any external seal if the input drive is at the low pressure end and does not extend outside the high-pressure casing, which then has no communication with the outside atmosphere but only (by leaks) with the low pressure case. In order to guard against excessive high pressure in the second stage case due to very rapid changes of delivery demand, then—in addition to the usual relief valve between the initial inlet and the final outlet—it is desirable to use a similar relief valve for half this pressure difference between the high-pressure and low-pressure cases. The volume of fluid to be delivered by the first stage to the second will depend on deviations from the nominal displacements of the first and second stage pumps, the difference in the volumetric efficiency of the two pumps due to small manufacturing differences, change of volume of the system due to fluid compressibility and dilation of the high-pressure casing together with leaks from this to the low-pressure casing. For this reason the maximum capacity of the first stage must be somewhat in excess of the maximum capacity of the second stage, which in the example illustrated is obtained by allowing a larger swash-plate tilt. It will be obvious from the figure that if the pressure P_1 in the casing of the second stage tries to fall below half the final delivery pressure P_2, then the stroke of the first stage will increase until the pressure P_1 increases as necessary. The amount of the steady state and transient adjustment depends on the control input which varies the second stage stroke and the factors above mentioned, all of which are automatically looked after.—*April* 19, 1961.

MINING EQUIPMENT

865,761. January 8, 1958.—DISCHARGING HIGH-PRESSURE FLUID FOR BLASTING PURPOSES, Austland, Ltd., 62, London Wall, London, E.C.2. (*Inventor : David Lincoln Dowie.*)

This invention relates to devices for blasting coal or rock by high-pressure air. In the accompanying drawing, the device has a tubular portion *A* for insertion in a hole previously drilled in a coal or rock face. The tubular structure is attached to a part *B*, connected by a coupling *C* to a reservoir *D* containing air at the high pressure required for blasting. Air is retained in the reservoir by a release disc *E* or alternatively a valve may be employed for this purpose. The interior of the tubular portion is filled with water, escape of which through the discharge apertures *F* is prevented by means of an easily rupturable membrane. The discharge apertures



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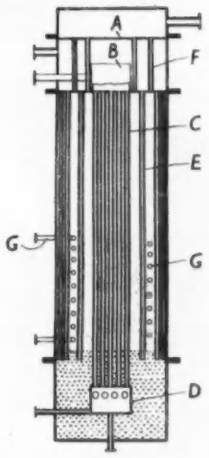
are inclined rearwardly so that a discharge of fluid tends to retain the device in the bore-hole. In an alternative arrangement as shown in the detail drawing there are provided radial discharge apertures and the means for retaining the device in the bore-hole comprises pivotally mounted expanding claws *G*. In one mode of employing the device it is inserted into the bore-hole after water has been introduced into its interior by any convenient means. Air from a suitable high-pressure source, e.g. at 10,000 lb per square inch, is then supplied to the reservoir body to build up pressure until the release disc is ruptured, whereby the high pressure is transmitted to the coal or other mineral through the liquid. By this means higher initial pressures are transmitted and smaller quantities of air can be used as compared with the known devices, resulting in economy and less loss of energy expansion of the discharged air. Also when winning of coal it is broken into large pieces and there is less scatter, in addition to the more economical use of the high pressure air.—*April* 19, 1961.

CATALYTIC REACTORS

866,419. January 20, 1960.—CATALYTIC REACTOR, The Coal Tar Research Association, Oxford Road, Gomersal, near Leeds, Yorkshire. (*Inventor : Welsley Donald Betts.*)

This invention relates to catalytic reaction apparatus of the boiling (fluidised) bed kind. especially those for the oxidation of naphthalene to phthalic anhydride, having a boiling bed reactor for the oxidation step and a heat exchanger for preheating the air or other oxygen-containing gas, utilising the reaction heat of the oxidation process. The reactor consists of four sections, header, naphthalene evaporation and air distribution, heat exchange and detrainment sections. The reactor head contains two concentric shells *A* and *B*, the outer being a header for primary and the inner a header for secondary air. Header *B* supplies a number of central pipes *C* terminating in jets (not shown); which project into a naphthalene evaporator. This consists of a closed box *D* with a number of side ports and pipes for supplying naphthalene and removing residues respectively. Header *A* supplies primary air to a number of pipes *E* which also terminate in jets (not shown) and their number and diameter are governed by the amount of heat exchange required between the catalyst and reaction gases and inlet primary air ; the number of pipes is also related to the total number of tubes by the ratio of secondary to primary air split. Similar considerations apply to the pipes *C* and the pipes *E* do not project to the same depth as the secondary battery. Passing through the header *A* are a number of tubes *F* for removing the reaction gases after heat exchange. A water cooling coil *G*



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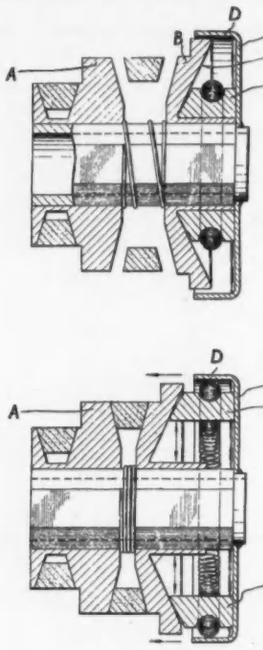
in the interstices of the primary tubes removes excess heat. The base of the casing around the naphthalene evaporator, is filled with inert material, which will not fluidise, such as gravel, and the depth is such as to immerse the ends of the primary air tubes *E*. Initially the primary and secondary air streams are heated to start the reaction. With the onset of the reaction heat is liberated in the catalyst bed and can be utilised to heat the air streams. Heat exchange is effected across the pipes. The secondary air stream is bubbled through the naphthalene in the evaporation box and supplies the necessary heat for vaporisation. Heat is also transferred down the catalyst bed and completes preheat to the reaction temperature. Excess heat is removed from the bed by the cooling coil. Satisfactory air distribution is effected by the disposition of pipes and pressure differences, which would otherwise upset the quality of distribution, are obviated by terminating each pipe with a jet. The reaction gases after leaving the bed enter a detrainment section to prevent carry over and further heat exchange takes place in this section. The advantages of this type of converter are given. No separate heat exchanger is required thus reducing external surface heat losses appreciably. Heat exchange can be accomplished at the source of maximum energy, thus best utilising the benefits of available heat. Exchange takes place between clean air and the inside of the pipes, and the catalyst on the outside keeps the surface clean of fouling material. The complexity of heat exchanger design is reduced since no floating header with an expansion joint is required. No separate evaporator is required and heat is supplied almost directly from the reaction to effect vaporisation.—*April* 26, 1961.

POWER TRANSMISSION

866,550. July 22, 1959.—CENTRIFUGALLY OPERATING CLUTCHES, Wolseley Engineering, Ltd., Electric Avenue, Witton, Birmingham 6 (a communication from V-Plex Clutch Corporation, 550, West Main Street, Hagerstown, Indiana, United States of America).

This invention relates to a centrifugally operating clutch by which at different speed rates a belt will be gripped or released to transmit power or to idle. One form of construction of clutch is shown in the drawing. The clutch comprises a belt drive pulley in which one cheek *A* is fixed and the other *B* is slidable in order that at different speeds a vee-rope can either idle as shown in the upper view or transmit a drive as in the lower view. The cheek *A*, on a tubular spindle, is driven by a vee-pulley. The spindle provides a sliding non-rotatable connection for the sleeve carrying the cheek *B*. A thrust ring *C*, connected to the spindle has an inwardly turned

annulus *D* which embraces the periphery of the movable cheek. This ring together with the outer inclined side *E* of the cheek *B*, provides a pocket housing centrifugal weights *F*. One side of each weight seats against the thrust ring and the opposite



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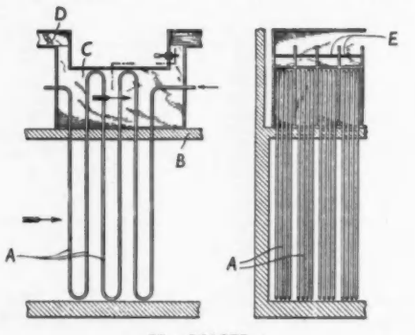
side co-operates with the similarly inclined outer side *E* of the movable cheek *B*. The weights have a surrounding annular groove for a weak garter spring which holds the weights into a limiting inner position corresponding to the maximum axial distance between the fixed and movable cheeks. As the speed of rotation of the clutch increases the weights move out under centrifugal force and their inclined sides displace the movable cheek towards the fixed cheek. This causes the belt to be gripped between the cheeks and tensioned, the belt climbing upon the sides of the cheeks as the distance between them diminishes.—*April*, 26 1961.

STEAM GENERATORS

866,275. August 1, 1958.—SUPERHEATERS AND STEAM GENERATORS, Sulzer Frères, Société Anonyme, Winterthur, Switzerland.

It is an object of this invention to overcome or reduce the drawbacks of the known arrangements for keeping constant the temperature at which steam emerges from the superheaters of steam generators. One embodiment of the invention is specifically described by way of example with reference to the accompanying drawing. The superheater comprises



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tubes *A* which extend from the combustion gas flue, through the boiler brickwork *B*, to the outside of the combustion gas flue. The cooling surfaces of the tubes are situated in a heat exchanger *C* which has a regulating valve *D* and is divided into several chambers connected in parallel. Each of the cooling chambers is equipped with an adjustable sliding plate or damper *E*. The steam flows in series through the superheater tubes in the direction of the arrow while the cooling medium flows through the heat exchanger in countercurrent to the steam. The cooling air, after leaving the heat exchanger, can be used as preheated air in the furnace. It is also possible to use a liquid cooling medium in the form of boiler feed water.—*April* 26, 1961

Catalogues and Brochures

CABLEFORM, Ltd., Romiley, Cheshire.—Leaflet describing the CF69A transistorised photo-electric detector.

PRECISION CHAINS, Ltd., Clayton Lane, Manchester, 11.—Catalogue No. 53/0 entitled "Steel Conveyor Roller Chains."

P. P. PAYNE AND SONS, Ltd., Haydn Road, Nottingham.—Illustrated brochure covering a range of specialised packaging and labelling products.

THE INCANDESCENT HEAT COMPANY, Ltd., Cornwall Road, Smethwick, Birmingham.—Leaflet No. FP5 illustrating the use of "Whiting" dust arrestors on cupolas.

THE NATIONAL GAS AND OIL ENGINE COMPANY, Ltd., Ashton-under-Lyne.—New publications revised to include the most recent information available on National R4A, F and B series engines.

THE NELSON ENGINEERING COMPANY, Ltd., Netherfield Works, Nelson, Lancashire.—Illustrated catalogue showing examples of non-standard, rotary and static electrical equipment made by the company.

AMBUCO, Ltd., Standbrook House, 2-5, Old Bond Street, London, W.1.—Folder giving technical information on the Ambuco venturi scrubber which is made under licence from Waagner-Biro of Austria.

HACKBRIDGE AND HEWITTIC ELECTRIC COMPANY, Ltd., Walton-on-Thames, Surrey.—Publications D.B. 5/6 and R. 193/2 illustrating and describing large transformers, and silicon and germanium rectifiers respectively.

CLYDE CRANE AND BOOTH, Ltd., incorporating JOSEPH BOOTH AND BROTHERS, Rodley, Leeds, and CLYDE CRANE AND ENGINEERING COMPANY, Mossend, Lanarkshire.—Revised edition of the "Booth Handbook of Overhead Cranes."

RADIOVISOR PARENT, Ltd., Stanhope Works, High Path, London, S.W.19.—Illustrated leaflet on electronic "Die Saver" which prevents die damage by continually monitoring power press operations and making sure that the component is ejected from the die before the press is allowed to commence the next stroke.

FRIED. KRUPP SCHMIEDE UND GIESSEREI, Essen, Altendorfer Strasse 100, Germany.—Illustrated brochure in English entitled "Krupp Rolls," giving details of rolls for hot and cold rolling of steel and non-ferrous metals. It contains a brief historical survey of metal rolling, followed by technical information on the selection of rolls for various duries. Advice is also given on the care and treatment of rolls, and on the causes and prevention of damage to rolls during use.

TAYLOR WOODROW (BUILDING EXPORTS), Ltd., 41, Welbeck Street, London, W.1.—Leaflet describing a new structure known as the "Arcon" Portal building. It is designed primarily for overseas use where superimposed loading requirements do not exceed 6 lb per square foot, and will also withstand, where necessary, wind loadings of 100 m.p.h. There is a choice of five different spans, 33ft 4in to 66ft 8in, in two alternative heights, nominal heights to eaves of 14ft 6in or 20ft 6in.

COMMUNICATION SYSTEMS, Ltd., Norfolk House, Norfolk Street, London, W.C.2.—Illustrated brochure describing some of the equipment, supplied, installed and maintained by the company, including private automatic telephone exchanges, telephone systems connected to the post office service, cordless switchboards, intercom telephone systems, loudspeaking telephone systems, production control communication systems, staff locator systems, telephone dictation recording systems, sound distribution systems and time systems.

SOCONY MOBIL OIL COMPANY, INC., 150E 42nd Street, New York 17, N.Y.—Technical bulletin describing the free-piston engine. It explains, in simple language, what the free-piston engine is and how the free-piston gasifier works. Further paragraphs deal with the bounce chamber, the air compressor, the power cylinder, the control of power output, starting and stopping, cooling, and lubrication. Typical performance data are presented for three installations : a cement plant in Lebanon ; the gas turbine vessel "Goodwood," and a test installation at the Smith's Dock Company, England.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

To-day to Sun., May 19 *to* 21.—Annual Conference, Grand Hotel, Brighton.

Tues., May 23.—PORTSMOUTH AND DISTRICT BRANCH : Committee Rooms, Ministry of Labour Offices, Lake Road, Portsmouth, Meeting with Electrical Association for Women, 7.30 p.m.

Fri., May 26.—NOTTINGHAM BRANCH : Grange Farm, Toton, Ladies' Night, 7 p.m.

DRAWING OFFICE EQUIPMENT AND MATERIALS EXHIBITION

Mon. to Thurs., June 5 *to* 8.—Royal Horticultural Society's New Hall, Westminster, London, S.W.1, First National Exhibition.

INSTITUTE OF FUEL

To-day, May 19.—Bournemouth, A Summer Meeting and Conference on "Waste Heat Recovery from Industrial Furnaces."

INSTITUTE OF PETROLEUM

To-day, May 19.—Hotel Metropole, Brighton, Symposium on "Engine Testing of Crankcase Lubricating Oils," 9.30 a.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Fri. to Sun., May 20 *to* 28.—Savoy Hotel, Blackpool, Annual Business Conference.

INSTITUTION OF CHEMICAL ENGINEERS

Tues., May 30.—Royal Commonwealth Society, Craven Street, London, W.C.2, Symposium on Biochemical Engineering, 2.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., May 30.—UNWIN MEMORIAL LECTURE : Great George Street, Westminster, London, S.W.1, "The Work of the Institution's Research Committee," J. F. Baker, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Thurs., May 25.—UTILISATION SECTION : Savoy Place, London, W.C.2, Annual Lecture on "Electric Traction," J. A. Broughall, 5.30 p.m.

Mon. to Fri., May 29 *to June* 2.—Summer Meeting in London.

INSTITUTION OF MECHANICAL ENGINEERS

To-day and Sat., May 19 *and* 20.—NORTHERN IRELAND GRADUATES' SECTION : Two-day visit to industries in the Dublin area.

Sat., May 27.—Joint Annual Summer Visit of the Graduates' Sections of the Institutions of Civil and of Electrical Engineers to London Airport.

Wed., May 31.—YORKSHIRE BRANCH : Summer Visit to George Bassett and Co., Ltd., Sheffield, 2.10 p.m.

INSTITUTION OF PLANT ENGINEERS

Tues., May 23.—SOUTH WALES BRANCH : South Wales Institute of Engineers, Park Place, Cardiff, "The Measurement and Analysis of Noise in Factories," G. Berry, 7.30 p.m.

Thurs., May 25.—MERSEYSIDE AND NORTH WALES BRANCH : The Blossoms, Chester, "Men, Method and Material—in that order," K. S. London, 7.15 p.m.

Sat., May 27.—BIRMINGHAM BRANCH : Imperial Hotel, Temple Street, Birmingham, "Acoustics," E. G. Ewing, 7.30 p.m.

ROYAL AERONAUTICAL SOCIETY

Fri., June 2.—ROTORCRAFT SECTION : Lecture Theatre, 4, Hamilton Place, London, W.1, "Development of Stabilising Equipment for Helicopters," P. D. Macmahon, 6 p.m.

ROYAL SOCIETY

Thurs., May 25.—Burlington House, Piccadilly, London, W.1, Discussions of the papers, "The Gravity Field of a Particle. II," Sir Charles Darwin, and "The Aerodynamic Theory of Sails. 1. Two-Dimensional Sails," B. Thwaites, 4.30 p.m.

ROYAL SOCIETY OF ARTS

Thurs., May 25.—HENRY MORLEY LECTURE : John Adam Street, Adelphi, London, W.C.2, "Bauxite and Aluminium with particular reference to the Commonwealth," Wilfred Brining, 5.15 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Tues., May 23.—Manson House, 26, Portland Place, London, W.1, Annual General Meeting, 6 p.m., Presidential Address, 7 p.m.

TIMBER DEVELOPMENT ASSOCIATION

Wed., May 24.—Dorchester Hotel, London, W.1, Annual General Meeting, 11 a.m., followed by the annual luncheon.

Advanced Engineering Courses

A Summer School in Health Physics (Radiation Protection). DEPARTMENT OF CHEMICAL ENGINEERING AND CHEMICAL TECHNOLOGY, Imperial College, South Kensington, London, S.W.7. The course, which runs from July 3 to July 14, is designed to provide basic information on principles, but will include detailed lectures on certain topics which are essential to an understanding of the subject. It is suitable for graduates in science or medicine and should be of interest to radiation protection officers in the universities or in industry, medical officers of health, factory inspectors and others concerned with radiation protection. The syllabus will include lectures on basic physics, biological effects of radiation, genetics, the external radiation hazard, hazards from bone-seeking isotopes, measurement of the radioactivity of the body, radiochemical laboratory design and management, natural activity of food and water, waste disposal and legal aspects. Practical work with radioactive materials, and visits to other establishments, will form part of the course. Fee £26 5s.

Control Engineering. DEPARTMENT OF MECHANICAL ENGINEERING, Nottingham and District Technical College, Burton Street, Nottingham. A one-week post-graduate course to be held from Monday, May 29 to Friday, June 2. The course is designed to present the fundamentals of control engineering in such a manner that engineers who are not at present actively engaged in control engineering will be able to obtain an insight into the nature and solution of the problems involved in this branch of engineering. The course will also be of value to those already working in this field, for in addition to the presentation of fundamental concepts there will be also a number of specialist lectures and an exhibition of control equipment. The course is intended for engineers possessing a degree or equivalent qualification. Fee £3 3s.

Post-Graduate Course in Engineering Production. THE UNIVERSITY OF BIRMINGHAM, Edgbaston, Birmingham, 15. The primary object of this post-graduate course of studies, which occupies one academic year, is to provide advanced education and training for production engineering and management positions in industry. Graduates of Birmingham and other Universities, with degrees in science subjects and with satisfactory industrial experience, and other students with equivalent qualifications, are eligible for admission. A systematic course of studies on the principles of Engineering production and on industrial management subjects is provided together with suitable practical work in the form of special research projects and case studies in industry. Application for admission to the course commencing each October should be made to the Registrar not later than July 30. Fee £95.

Post-Graduate Course in Operational Research and Allied Studies. THE UNIVERSITY OF BIRMINGHAM, Edgbaston, Birmingham, 15. The object of this post-graduate course of studies, which occupies one academic year, is to provide advanced education and training for graduates who intend to take up careers in operational research in industry. Graduates of Birmingham and other Universities with first or second class honours degrees in science, mathematics or economics (with statistics) and some industrial experience are eligible for admission. A systematic course of studies is offered, leading to examinations in six subjects. In addition, each student is required to undertake an investigation of a practical industrial problem and to submit a report for examination. Application for admission to the course commencing each October should be made to the Registrar not later than July 30. Fee £95.

Welding Technology. THE COLLEGE OF AERONAUTICS, Cranfield, Bletchley, Bucks. A one-year post-graduate course which will take place during the Autumn, Spring and Summer terms of the academic year 1961–62. Autumn term commences on October 9. The purpose of the course, which has been sponsored by the Institute of Welding and the British Welding Research Association, is to provide students of graduate status in either metallurgy or engineering with a specialised training to fit them for posts in the design, development and production departments of the many industries where welding is now vital. A range of subjects will be covered with a particular concentration on the special metallurgical consideration inherent in welding ; the welding processes, their characteristics and fields of application, and design for welding and the essential production techniques. Fees, British students £75 ; Commonwealth students £250 ; foreign students £350. Residence £126 10s.

Combustion Engineering. PRESTATYN HOLIDAY CAMP. A residential refresher course for works and plant engineers, to be held from Monday, May 29 to Saturday, June 3. The aim of the course is to provide engineers concerned with the burning of substantial tonnages of solid, liquid and gaseous fuels on boilers and furnaces with an integrated series of lectures which will not only examine and review existing good practice, but will also introduce and consider the latest developments in the field of combustion. Starting with a study of available fuels, the syllabus will include the principles of combustion for all types of boiler and furnace plant with the various auxiliaries and ancillary items of equipment, instrumentation and automatic controls. Fee £12 12s.